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Safety Cycling

BY

G. D. LEECHMAN.

WITH

AN INTRODUCTION

BY HENRY STURMEY.

LONDON:
ILIFFE & SON, 3, ST. BRIDE STREET, E.C.

Iliffe & Son, Coventry and London.

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PREFACE.

THOUGH a large number of books have appeared from time to time upon the subject of cycling, there would still appear to be room for another, provided it be up to date in information and moderate in price. The popular shilling is beyond criticism, but I am fully conscious that what I have written is not—corrections and suggestions will be welcomed! Few of the existing publications on the same topic deal at any considerable length with the construction of the cycle, and, though I have dwelt on the subject here, I have aimed at telling the novice what points to look for, rather than describing specific articles.

As my practical acquaintance with the "velocipede" dates back to the seventies and the "boneshaker," and includes some experience as a manufacturer, I have been able to write very largely from personal observation, but this has been supplemented where necessary from other sources. The bulk of the following pages will be more useful to the novice than to the "old hand," but I hope even the latter may find sufficient new matter to gain his recommendation, rather than condemnation.

G. D. L.

Coventry,
February, 1895.

AN INTRODUCTION,

WITH

SOMETHING ABOUT THE "GIRAFFE"

OR HIGH-FRAMED SAFETY,

By Henry Sturmey,

Editor of *The Cyclist*, "The Cyclists' Year Book," and *Photography*, and author of "The Indispensable Bicyclists' Handbook," "The Tricyclists' Indispensable Handbook," "The Indispensable Handbook to the Safety Bicycle," "The Complete Guide to Bicycling," &c., &c.

MY first recollections of the cycle, or velocipede as it was then called, date from somewhere in the neighbourhood of 1863, when I remember seeing in the neighbourhood of Yeovil a man on what then looked to me like a truck or hand-cart running rapidly downhill, past both a loaded omnibus and the carriage in which I was being driven, apparently without movement or effort on his part. I recollect being told it was a velocipede, and that the man "turned it with his hands," and I have a lively remembrance that it was a nine days' wonder with me at the time, and that I kept talking and bothering my relatives with enquiries about it for some time afterwards. I subsequently learned the strange machine was a four-wheeled velocipede, worked with pedals on long swinging levers attached to a cranked axle and steered by a Bath-chair handle, the whole contrivance, of course, constructed of wood, and weighing close on two hundredweight. Things have altered since then, although the bicycle as I knew it first was a vastly different thing to the beautiful machine of to-day. The two-wheeled machine made its appearance in Weymouth, where I

then lived, in the early seventies, and my first practical acquaintance with it was made in the autumn of 1873, after something like two years' envious watching of the tortuous, and not always edifying, evolutions of the three or four local enthusiasts who, though they were heroes in the eyes of some—myself amongst the number—seemed to make themselves the laughing stock of the rest of the population, who looked upon them as fools for their pains and little short of lunatics. The machines which were then in use weighed about 80lbs., and were built almost entirely of wood. They had wooden wheels and frames, equal, or nearly equal, wheels, long steel springs running from end to end of the machine on which the rider sat, high iron handles with large curved leg-rests on each side, and were worked by cranks and pedals on the front wheel. Most had iron tyres, but some few of the latest models had both wire spokes and flat rubber tyres, and it is interesting when comparing the machines of that period with the cycles of the present day to note that, although between then and now the design of the machine underwent an entire change, it has come back practically to its original form, with the substitution of a chain-driven back wheel for the direct-driven front wheel of the past. At the time of which I speak the enormous mass of cycling literature, with which the market is now flooded, was entirely absent, the only information on the subject being a little book entitled "The Modern Bicycle and How to Ride it," by Charles Spencer, and occasional articles by Harry Hewitt Griffin in the columns of *The Bazaar* and *The Country*, together with the correspondence columns of the *English Mechanic*, in which enthusiastic velocipedists aired their views. About the time I commenced to ride, the machine began to be rapidly improved, until by 1876 iron had entirely replaced wood in machine construction, the rubber tyre was universal, and the front wheel had grown, whilst the back had been reduced, until the former was twice the size of the latter. In that year the first cycling newspaper, *Bicycling News*, made its appearance, and from that time onward the march of progress continued steadily to advance, and with the increasing popularity of the cycle as a means of conveyance, new

books and publications continued to increase, until to-day the cyclist is the best catered for class in the world. As for the machine, the driving wheel grew higher and higher, and the back wheel smaller and smaller, until men rode right on the top of the front wheel, bestriding as large a one as the length of their legs permitted them to do, very tall men using wheels as large as 60in. in diameter and even larger, one or two instances of wheels as large as 66in. being known, whilst the back wheel was reduced to as low as 16in., and the weight of a racing bicycle brought down below 30lbs. Many men—and women, too—desired to enjoy the pleasures of the wheel, but the danger of the high machine, or rather of learning to ride it, prevented, and from about 1880 various forms of tricycle—really the older machine of the two—enjoyed much popularity, until by 1886 quite one-third of the riders of the kingdom were tricyclists. Then various forms of low or "safety" bicycles, including the rear-driving safety, the type of the present day, introduced the previous year in a practical form by J. K. Starley & Co.—then Starley & Sutton—began to attract notice, and, by giving the advantages of the bicycle to men of mature years and others whose amount of courage was not sufficient to let them essay the perils of the high or "ordinary" machine, opened up a new field for trade, which, with the aid of the pneumatic tyre, introduced commercially in 1890, in the course of one or two seasons entirely drove the high machine out of the market, whilst makers' attention being entirely devoted to the improvement of the safety, to the utter neglect of the till then much considered tricycle, that form of machine, too, despite its many advantages, lost its hold on popular favour, and left the rear-driven safety of to-day complete master of the field for the time being.

Despite, however, the undoubted mechanical superiority and greater speed of the modern safety, the machine of ten years since had its attractions, and died hard with its votaries, who in large part only betook themselves to the lower form of machine through force of circumstances, said circumstances being the impossibility as years rolled on of getting an "ordinary" bicycle with anything in the shape of "up-to-date" fittings and mechanical details. Whilst the modern form of machine possesses advantages in the

placing of the rider between the wheels, and not over either, in the better adjustability of the position to suit individual requirements, in the greater ease of mounting and dismounting, and in the apparent sense of security induced by a closer approach to the ground, the older type was largely free from that bugbear of the modern safety—side-slip; in the event of a fall the rider had more time to get clear of the machinery, and, above all, the position, placing the cyclist above his surroundings, gave an enjoyment and zest to the pastime impossible to secure on the more lowly mount, whilst in muddy weather the shoes were not filled with mud and water, poured into them from the front wheel, as is the case with the low machine. Largely with a view to combine, if possible, the mechanical advantages of the low machine with the personal enjoyment and pleasure derivable from riding the older form of bicycle, a new type made its appearance a year ago, which, whilst retaining the low wheels, chain gear, rear-driving and constructional details of the safety, gave the rider nearly the height of position obtained in the older form of machine. This type, known as the high-framed safety, quickly became nicknamed—after a fashion prevalent in cycling circles—the "Giraffe," doubtless in consideration of its length of "neck" or "head," and, as I have since its introduction taken almost entirely to it for pleasure riding, the following account of its behaviour may prove of interest. Its construction is simple, and but very little removed from that of the ordinary safety, the chief difference being that the crank-bracket, instead of being placed as near the ground as will permit of the machine being safely ridden without danger of the pedals touching the ground, and the tubes of the frame brought down accordingly, has the crank-bracket carried at about the middle of a direct line running from the centre of the back wheel to the bottom of the steering head, and the rest of the members of the frame lengthened upwards sufficiently to place the saddle and handles high enough above the pedals to ensure comfortable riding in a fairly upright and uncramped attitude, the raising of the frame necessitating the lengthening of the wheel-base some few inches, to ensure proper stability and steadiness in steering. The result is a machine on the principle of the low safety, with a saddle placed

some 8in. or 9in. higher than usual. Not a great deal, after all, but quite enough to effect a wonderful difference in the riding and appearance of the machine. First and foremost the rider is elevated above his surroundings, a fact which enables him to see the more readily over hedges, and get a better view generally of the country around, whilst the effect on the mind, after the novel position has been got used to, is certainly more exhilarating and attractive. For myself, this one point alone has restored much of the enthusiasm and keen enjoyment for the pastime felt in the earlier days, which I must confess had to a certain extent disappeared since I was, with other old "ordinary" men, compelled to take to the lower machine, which I have looked upon more in the light of a mere walking machine for the facilitation of movement than anything else. Then the position, or, rather, the attitude, of the body is freer and less cramped, more comfortable, and, at the same time, more graceful than has been the case with the safety. I say "has been" advisedly, for this improved attitude is not necessarily an adjunct of the high frame, but can be equally well obtained on the low machine, which is rapidly being altered to meet an improved flow of ideas brought about somewhat by the better attitude adopted by riders of the high machine, and a final surfeit of the "monkey-on-a-stick" posture of the past, with its necessarily humped back and unhealthy chest contraction. Still, the high machine gives a rational position in the fullest possible degree, and with a T or "universal" seat-pillar enables the rider to assume the most comfortable position possible for ordinary riding and touring purposes. Then, again, the elevated position of the feet lifts them clear of the steady stream of mud thrown on them by the front wheel of the lower machine, even when protected by a mudguard. It is true the feet are not absolutely free from mud after a fast ride on a wet, muddy day, but the coating is one of fine water splashes rather than a downpour of liquid mud. In point of side-slip I have found the high machine also advantageous, showing much less tendency thereto than the lower type. In this connection, however, it is only fair to mention that I have invariably used non-slipping tyres, a course which I advise everyone to follow who values his personal safety and peace of

mind when riding over muddy roads. That pneumatic tyres with smoothly polished surfaces, which slip at the slightest encouragement from greasy road surfaces, should be persistently put out for promiscuous sale amongst all-round road riders is, in my opinion, a great mistake, seeing the serious character which accidents from side-slip—which are absolutely out of the power of the rider to prevent—frequently assume. To return, however, to the high machine. I find greater comfort when descending hills with the feet on the foot-rests attached to the lower portion of the frame, and the steering is much steadier under these conditions than on any machine I have ever before been on, whilst by reason of the more nearly vertical position assumed, steady hill-climbing is undoubtedly rendered easier, the weight of the rider being brought into use for that purpose more fully than is possible with a more backward position. In point of luggage-carrying capacity, too, it appeals very strongly to the tourist, who will find in the large squarely open frame, as well as in the two long back tubes below the saddle, ample accommodation, with points of attachment ready to hand for a far greater amount of luggage than can be carried conveniently on any other machine but a tricycle. To the lay mind the extra height of the machine appears formidable as a bar to an easy mount and dismount, as well as in point of view of the greater distance to fall in case of a spill, and I must confess that, after a long course of low machine riding, the position at first, although several inches short of my old 54in. "ordinary," did appear somewhat disconcerting, whilst it appeared quite an acrobatic feat to get into the saddle, in particular the lift of the left foot on to the step seeming rather a stretch. This, however, was only because the muscles had been trained otherwise, and a fortnight's use of the machine quite removed all nervousness when in the saddle, as well as made both mounting and dismounting easy, so much so that I now mount with a single hop, and, in fact, find getting on to the low machine, where—being a tall man—everything seems underneath me, the more awkward of the two. In the event of a spill, too, I hold that the additional terrors of the high machine are purely imaginary, as should anything bring him down, the cyclist will have more time to save himself

and get out of the machinery, for it is a well-known and recognised fact that falls from the safety bicycle are often more serious in their results than they ever were from the "ordinary," or old type of machine, despite the fact that the dreaded "cropper" or fall over the front possible with the old style is not possible with the new. In weight the giraffe is at a slight disadvantage over the safety by the weight of about a couple of feet of steel tubing, and the slightly stronger construction necessary to compensate for its greater length, a difference which, however, need not necessarily mean more than a pound or a pound and a half, whilst as to the point of lack of speed which has been urged against it, I contend that, *properly* built, it is fully as fast as any safety of similar style and weight. It must be remembered that it is essentially a touring machine, so that in a comparison of possible speed it is unfair to compare it with a light road-racing safety. It is true it has a bad name in this respect, but the reason is not far to seek. The first experimental models were far from perfect, and much too short in the wheel-base. They consequently steered erratically at speed, and this, coupled with the riders themselves being more or less nervous and unaccustomed to the high position, caused them to obtain a reputation as undeserved as unenviable, more especially as the majority of the makers who rushed into building them without having fully grasped their points, had only these earlier models to work to, and very few machines indeed have been sent out built to proper proportions, the invariable cause of trouble being shortness of wheel-base, the majority being little, if any, longer than the ordinary safety, whereas no giraffe should measure less than 48in. between the central points of contact of the two tyres with the ground. If this measurement be adhered to as a *sine quâ non*, and the rest of the frame carried up in accordance with the rider's height, so that no more than 3in. of either handle-stem or seat-pillar project above the frame when properly adjusted to his riding requirements, the rider will have, in my estimation, an ideal touring mount, more especially if he insists on "flat" handle-bars, "universal" seat-pillar, and foot-rests on the lower frame, and in making his first adjustment of the machine fixes the saddle with its nose 2in. back of a vertical line

drawn through the centre of the crank-axle, and the handles on a level with the top of the saddle.

Taken generally, the machine will be found more suitable for tall riders than for short ones, and although I like it so well for my own riding, I do not recommend it to the choice of nervous or timid men, who will be better suited by the greater feeling of security given by the safety, or, better still, by the tricycle. Let no one judge a giraffe by a first trial, but ride it steadily for a month until he is quite used to it, when, if I mistake not, he will like it too well to relinquish it. I know of no man who has given it a proper trial who has relinquished it save one, and he was a short man and a scorcher to boot, and as the high type is intended for touring, and not for scorching, it was scarcely likely to suit. I have been asked why, if the machine is all I claim for it, it is not more largely used than it is, to which I reply that the causes are three: First, but two makers ever built the machine on really sound lines; second, as a consequence it got a name for slowness, which passed on from mouth to mouth, and, copied parrot-like by some of the unpracticals of the cycling press, gave it a bad reputation to start with; and last, but by no means least, from the fact that a very large proportion of the riders of the present day are of too timid a nature to attempt to get used to it, it has not really had a fair trial. Three very powerful retarding factors, which have served as a very effectual bar to popularity.

CHAPTER I.

PRELIMINARY.

AS we have no new light to shed on the misty history of the velocipede we do not propose to set out here at length facts which have already been ably presented by other writers. Whoever originated the first hobby-horse, and whoever invented the first rear-driving, pedal-propelled cycle, the gratitude of the wheeling world, maker and rider alike, is undoubtedly due principally to Mr. J. K. Starley for having produced and popularised the rear-driving safety bicycle, a machine which at the present time exhibits at one extreme no mean specimen of mechanical skill, and at the other a wonderfully accommodating nature in the matter of price.

We have mentioned the modern rear-driving safety bicycle, and we may say at once that in our opinion it is the safest type of bicycle, and perhaps the safest of all types of cycles, in existence. On the rear-driver the rider's weight is carried further behind the forward point of contact between the machine and the ground, and nearer to the ground than in any other style of two-wheeler, which facts render forward falls (the falls necessarily most common on, or from, any progressive locomotive) less frequent, and of less consequence. The danger of side-slipping is no doubt its cardinal evil, but this defect is being rapidly overcome. The following comparative advantages are held by the machine: It is fast, especially uphill; can be geared to suit various conditions; is little affected by contrary winds; is fairly free from vibration; can be accurately adjusted to suit individual riders; easy to mount and dismount; steering is not interfered with by the pedalling; demands little attention to the road surface (except for punctures), and so allows scenery to be viewed well; lends itself well to the application of anti-vibratory devices; may generally be ridden "hands off"; fair capacity for carrying luggage; is providable with comfortable footrests; will stand against an ordinary kerb or bank; is light; can be easily taken through a narrow door, and stowed in a small space. On the other hand, it is somewhat complicated, and proportionately liable to get out of order; and, unless specially guarded, it is liable to get the chain clogged, and

to bespatter the rider on muddy roads. The geared ordinary, or front-driving safety, is more comfortable, less liable to side-slip, and has no chain to clog; but then it cannot disclaim a certain acquaintance with "headers," it is an inferior hill-climber, and offers no rest downhill, its height makes it less easy to mount and dismount, and it cannot be made to stand against kerbs, etc. If an elevated position be required, the giraffe pattern of rear-driver, with straight under-frame and raised pedals, saddle, and handles, affords it without greatly sacrificing the safe position and the footrests, and it is probably as little liable to side-slip, and no more exposed to the winds that blow, than the front-driver. The tricycle's disadvantages in the way of weight, wind, width, and three tracks, more than overbalance its unique readiness to stand still when required. Theory, and almost universal practice or use, agree in proclaiming the rear-driving safety bicycle the best type of cycle for general purposes.

An indirect but nevertheless great benefit of cycling is that it is almost impossible to concentrate the thoughts on any outside subject while riding. The attention is attracted first to one thing and then to another, so that the cyclist who starts out with "the blues" or a headache finds himself singing in a few minutes, and comes back from an hour's gentle spin with a gladsome mind and reinvigorated brain. So if the cyclist ride five or ten miles to his daily occupation, at a comfortable pace, he will find himself in far better trim for work than when he goes by train. There is very little danger in riding in the busiest London streets, so long as they are dry, and the cyclist keeps to the rules of the road and does not lose his presence of mind. Of course the rider should be quite proficient; if he can do a little trick-riding he may find it come in handy now and then.

Doctors, who were first inclined to be prejudiced against cycling, are now becoming more and more convinced of its value as a quickener of the vital powers when practised in moderation. Many riding themselves find a great gain in health, and, if it saves a horse, a considerable saving in pocket. One great advantage it has over most other exercises, the muscles are brought into play, the lungs filled with fresh air, the blood quickened in the arteries and veins, and the liver gently shaken up, without the patient getting into a violent heat or exhausted condition through carrying his weight.

We do not admit that there is any sport or pastime to even equal cycling, but variety is charming, and a turn at tennis or photography will help to make wheeling the more appreciated by comparison. Frequently the steel steed will enable one to reach the scene of action quicker than any other means, and may

even make all the difference between good fishing or cricket and none at all. It may not be out of place to say a word or two here respecting some allied sports and pastimes.

Cycling and Photography go remarkably well together; other modes of travelling do not offer so many and so good opportunities for taking a picture as does cycling, and the cyclist takes special pleasure in contemplating the twin result of his cycle and camera. Many of the C.T.C. hotels now make a speciality of dark rooms for the use of photo cyclists.

A quarter-plate or 5 × 4 camera, with three double backs and lens, etc., may be packed into a flat leather or waterproof canvas case, about 11in. × 8in. × 3in. This may be attached to the machine by an anti-vibration spring carrier.

Some prefer to carry their camera, etc., on their backs; speaking from experience of a knapsack, one soon forgets it is there; but it should be secured from slipping about sideways, or it may have a marked effect on the balance.

The cyclist camera should be strong, and as free from small loose parts as possible, duplicates of those that are necessary being carried. A folding lamp with fabric, not glass windows, or some golden fabric to put round the candle should be carried when on tour, so as not to spoil the plates when changing them. The plates should be numbered or otherwise marked to avoid the risk of using the same twice over. Plates may be safely carried if carefully wrapped up in something soft and well isolated. They may be sent by parcel post in the plate boxes, packed with hay in flat wooden boxes.

Further information on the subject may be obtained in *Photography*, a penny weekly journal, conducted by Mr. Henry Sturmey, editor of *The Cyclist*, and published at 3, St. Bride Street, London, E.C.

Cycling and Cricket or Tennis—If riding in flannels, see that the saddle is clean, and secure the trousers from catching in the gear or getting soiled with the oil. This may be done by folding the loose part of the trouser leg as if about to put on a gaiter, and securing in position with a safety pin or some of the handy hooks, etc., sold for the purpose, or the sock may be drawn up outside the trouser—though this does not look very elegant, and the stretching of the sock makes it liable to slip down round the ankle afterwards. The bat or racket and shoes may be strapped on the handle-bar carriers. Take care that the twine on the handle of the bat or strings of the racket are free from contact with the machine, or they will very quickly chafe through. It is a good plan to put the shoes under the bat or racket, so as to raise the latter away from the machine. Remember that fast cycling does not improve the running powers.

If you take your machine on to the cricket ground, put it somewhere out of the reach of the balls. Take off the bag and put it with your coat, etc., in the tent or other safe place. Put a lock and chain on the machine, and keep your eye on it to see that no one takes too strong a fancy to it.

Bathing, Rowing, Fishing, and Skating.—The cyclist has special facilities for indulging in these sports, but care should be taken to secure the machine against damage or theft, as it must perforce be left while engaged patronising them.

A short cycle ride is just the thing to ensure the full benefit being derived from a dip, as it promotes the circulation and induces warmth just at the right time. The gentleman's (very extensive) bathing outfit can easily be carried on the machine. Do not get into an excessive heat or a weary condition by riding too fast or too far before taking the bath. Do not bathe less than one and a half hours after taking a meal, and carry an oatmeal biscuit or two to be eaten while dressing. When bathing alone it is not wise to go out of one's depth. If you get cramp do not get frightened, as a very slight movement of the hands is enough to keep the head above water. Tension and slacken the cramped muscle in rapid succession. Don't stop in the water so long as to induce chilliness.

The rod and creel may be carried on the handle-bar. Take care that the rings and other fittings on the rod do not get chafed. Do not let any water, especially if salt, remain on the plated parts or run into the bearings of the cycle.

Few things are more wearisome than a long walk after skating. If the skates are carried on the machine, so arrange them that they do not rub one another, nor the blades rub anything, or the edge will be damaged. Be very careful of ruts in the road, as they are apt to cause side falls. Remember that steel and bones are often brittle in frosty weather. It is possible to ride a safety on the ice, but corners have to be taken with big curves, as the ice affords very little side grip to the tyres. Do not let a string of skaters hook on behind you, as the accumulated weight may break the ice, and they are almost certain to have you over when you try to turn. On the whole, cycling on the ice is best left alone.

Before proceeding to the more practical part of our subject, we will refer to three matters of a somewhat abstract nature (though they can make themselves exceedingly apparent at times), namely, gearing, vibration, and weight.

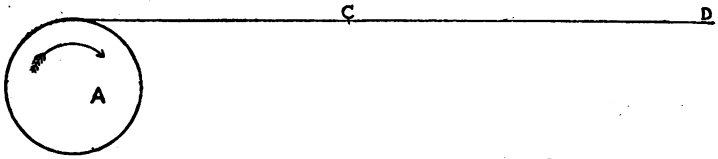
GEARING.

The gear of a rear-driving safety bicycle usually consists of a chain made with equidistant links running on two chain

wheels having projecting teeth on their outer edges; these teeth are so arranged as to work in the open links of the chain, both teeth and links being equidistant. One chain wheel is rigidly fixed to the driving or back wheel of the machine, and the other to the crank axle. The chain wheel or sprocket on the crank axle is made larger than the one on the driving wheel, which arrangement causes the driving wheel to revolve faster than the crank axle and pedals; as if the driving wheel were made to revolve only as fast as the crank axle, progress along the road at more than six or seven miles an hour would soon exhaust the rider's breath and tire him with fast pedalling. The machine, therefore, instead of being "geared level," must be "geared up." Let us explain our meaning more particularly. One chain wheel is rigidly attached to the back wheel of the machine so that they revolve as one piece, and a partial or a complete revolution of one necessitates and implies a corresponding partial or complete revolution of the other. The other chain wheel is similarly attached to the crank axle with a corresponding result. The cranks (to which the pedals are fixed) are also rigidly attached to the crank axle, so that a partial or a complete revolution of the pedals (on the cranks) round the centre of the crank axle implies a corresponding partial or complete revolution of the chain wheel on the crank axle, as if the pedals were attached to it direct. For the purposes of gearing the chain may be considered as a rigid, non-stretching connection between the perimeters or outer edges of the two chain wheels.

The circumferences of circles vary as their diameters; *i.e.*, not only does a larger circle measure more round the edge (or perimeter) than a smaller one, but it measures more just in the same *proportion* as a straight line drawn across through the centre of it (the diameter) measures more than the diameter of the smaller circle. For example, if the larger circle measured 9in. across, and the smaller one 3in., the larger one would measure three times as much round the edge as the smaller one.

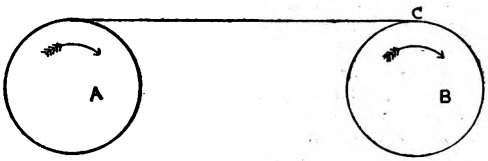
Instead of wheels with teeth and a chain let us take a wheel



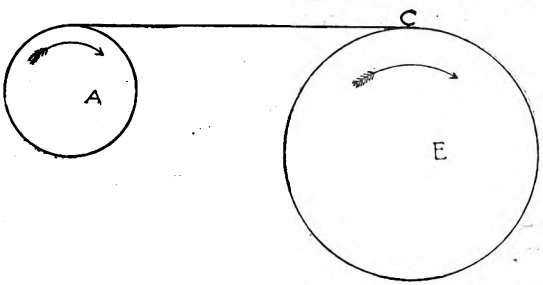
A with a cord wound round it two or three times. Suppose that A measures 9in. round, and that the free end of the cord reaches to C; if the end of the cord be pulled from C to a point D 9in.

further on, the wheel A will be turned round exactly one revolution in the direction indicated by the arrow. If the end be pulled to a point 3in., 5in., or 8in. beyond D, A will be turned round an additional $\frac{3}{8}$ths, $\frac{5}{8}$ths, or $\frac{8}{8}$ths of a revolution, as the case may be. On the other hand, if the end had been drawn only 2in., 4in., or 7in. beyond point C, A would have been turned only $\frac{2}{8}$ths, $\frac{4}{8}$ths, or $\frac{7}{8}$ths of a revolution, as the case may be, instead of a whole revolution or more.

Now, instead of pulling the end of the cord C along towards D, we will attach it to the edge of another wheel B, which is the same distance across as A, and therefore (like A) measures 9in.



round. If we turn B round exactly one revolution in the direction of the arrow, 9in. of the cord will be wound round it; an equal amount (9in.) will be unwound from A, involving its (A's) turning round exactly one revolution. And if B be turned round a fraction more or less than a whole revolution, A will be turned more or less than a whole revolution to the extent of the same fraction. But



if, instead of B, we take a larger wheel E, with a circumference measuring, say, 17in., and we turn it round a whole revolution we shall wind 17in. of cord on to it, and this will unwind 17in. from A. Now, 9in. of cord will go just all the way round A, and so, if we unwind 17in. from it, it is evident A will be turned round nearly twice (if 18in. were unwound from it it would be just twice).

The result is precisely the same if we use an endless open-linked chain instead of the cord and teeth on the wheels to prevent the chain from slipping, except that we can go on winding indefinitely. The number of links in the chain do not affect the gearing up or gearing down.

Supposing the chain to be tight and to fit properly on to the teeth of the wheels, if one of the chain wheels be revolved in one direction, the other wheel will revolve in the same direction; and if one of the teeth on one wheel travel, say, 6in. round its circle, any one of the teeth on the other wheel will also travel 6in. round its circle, whatever the size of that circle. Of course all the teeth on the same wheel travel the same distance round the circle, but the above is more easily expressed by noting one tooth only.

Now the pedals and cranks, as we have seen, travel equally revolution for revolution with the large wheel on the crank axle, and the driving wheel travels equally revolution for revolution with the small wheel on the hub. So that if the crank-axle chain wheel makes a whole revolution, or $\frac{1}{3}$, or $\frac{1}{5}^{3}$, or $\frac{9}{1}_{7}$, or any other fraction of the revolution, the pedals and cranks make a whole revolution or a fraction of the revolution corresponding with that made by the crank-axle chain wheel. And if the chain wheel on the hub make a whole revolution, or $\frac{1}{8}$, $\frac{7}{1}$, $\frac{1}{9}^{7}$, or any other fraction of a revolution, the driving wheel makes a whole revolution or a fraction of a revolution corresponding with that made by the chain wheel on the hub. Supposing the driving wheel to measure 28in. in diameter (= 88in. in circumference), the crank-axle chain wheel as before 17in., and the hub chain wheel 9in., also as before. Then if the large chain wheel (and therefore the pedals and cranks) make $\frac{1}{17}$ or one complete revolution, the hub chain wheel (and therefore the driving wheel) will make $\frac{17}{9}$ revolutions, and $\frac{17}{9} \times 88\text{in.} = 166\frac{2}{3}\text{in.}$ or 13ft. $10\frac{2}{3}$in. So that with this proportion of gear for one revolution of the pedals, the machine will run not about 7ft. only, but nearly 14ft., and the rider has to pedal only $\frac{9}{1}_{7}$ as fast as he would if his driving wheel went round once only for every revolution of the pedals.

It is customary to quote the gearing of a machine not by the distance the machine runs at each revolution of the pedals, but by that distance divided by $3\frac{1}{7}$, *i.e.*, by stating the diameter of a wheel that would cover the distance in exactly one revolution, so the machine of which we have just described the gearing would be said to be geared, not to 13ft. $10\frac{2}{3}$in., but to $\frac{13\frac{1}{4}\text{ft. } 10\frac{2}{3}\text{in.}}{3\frac{1}{7}} = 52\frac{8}{9}$in. or nearly 53in.

As the teeth are set at the same equal intervals on each chain wheel, instead of taking the trouble to measure the respective circumferences of each in inches, the respective number of teeth may be counted, and the calculations made with the number of teeth, and the diameter of the driving wheel in inches, instead of all the figures representing inches.

From the foregoing it will be seen that the answer to the common question, "What is your machine geared to?" may be found as follows: Ascertain the diameter of the driving wheel in inches, multiply this by the number of teeth on the crank-axle chain wheel, and divide by the number of teeth on the hub chain wheel. To take the same machine again

$$\frac{28\text{in.}\left(\begin{smallmatrix}\text{diameter of}\\ \text{driving wheel}\end{smallmatrix}\right) \times 17\text{in.}\left(\begin{smallmatrix}\text{teeth on crank-axle}\\ \text{chain wheel}\end{smallmatrix}\right)}{9\text{in.}\left(\begin{smallmatrix}\text{teeth on hub of}\\ \text{driving wheel}\end{smallmatrix}\right)} = \frac{28 \times 17}{9} = \frac{476}{9} = 52\tfrac{8}{9}\text{in.}$$

The driving wheel of the machine is sometimes a little more or less than the height given in its description, so a more exact measurement of the gear may be obtained by placing the machine on a smooth surface, *e.g.*, a wooden floor, noticing exactly the position of one crank or one tooth on the crank-axle chain wheel and marking the ground at the point where the driving wheel and it are in contact, then move the machine straight forward until the crank axle has made precisely one revolution, mark the new point of contact between the wheel and ground, and measure the distance to the first point of contact, and divide by $3\frac{1}{7}$, the result will be the gear of the machine. As it is rather difficult to make these markings, etc., exactly, it is best in practice to wheel the machine forward until the crank axle has made, say, exactly seven revolutions, and divide the distance between the points of contact by seven as well as by $3\frac{1}{7}$ or $(7 \times 3\frac{1}{7})$ 22. To be very exact, the tyres (if pneumatic) should be inflated to their usual density, and the rider should mount the machine and assume his accustomed position while making this calculation, so that the flattening of the driving wheel tyre may have its proper effect on the result.

This is useful if the gearing is closed in a case. Another way is to lift the driving wheel, rotate the crank axle exactly one revolution, and note first how many complete revolutions a marked point on the tread of the driving wheel tyre makes, and next how far the mark is from reaching the starting point again. This distance should then be divided by $\frac{22}{7}$, and then added to the diameter of the wheel multiplied by the number of complete revolutions.

VIBRATION.

If a wheel, while being moved along a level road, come in contact with an object at a point half or more than half as high as itself (the wheel), it will not surmount it, however great the impelling force may be, but if the point of contact be lower than the centre of the wheel it will surmount it if the force be great enough, and the lower the object the less will it resist the onward movement of the wheel—the less horizontal vibration there will be felt by the machine and rider. The vertical vibration will depend not only upon the height of the obstruction, but also upon its shape, for if the sides of the object touched by the machine be very long and smooth no uncomfortable vibration will be felt, but the nearer they approach the perpendicular the more jar they will produce. It will be seen then that any contrivance designed to reduce the vibration on a wheel should allow it to move both backward and upward, or at least in a direction which partakes of both kinds.

Vibration may be divided in another way, into small and large—the small usually being very rapidly repeated, as over rough gravel or well-laid stone setts; and the large being slower, as instanced in the comparatively undulating surface of a badly-worn macadamised (or, rather, granite) road. It is, undoubtedly, well in itself to isolate the rider from vibration, and equally undoubtedly well, though perhaps not so important, to isolate the machine from the same destructive bugbear. It is, therefore, right to make that part of the machine which first encounters the vibration-causing obstacles the one to minimise their effects—this part is, of course, the tyre. Now, it is obvious that unless the tyre were of very large diameter it would not cure the large vibration, though the more give there was in it the nearer it would be to attaining that object. If, then, the rider be not satisfied with the anti-vibrating properties of a mere tyre, or object to a very large one, he must either adopt further means in other parts of the machine or combine the two. Most cyclists find that a pair of pneumatic tyres about 1¾in. or 2in. in diameter, and a saddle spring suited to their weight, give sufficiently satisfactory results without undue complication. The parts of the machine which impart vibration to the rider are of course the points he touches—the saddle, handles and pedals. The first is provided with a more or less efficient spring, and the more the rider sits fairly on his saddle the less will he require any special arrangement for the handles. The old complaint against the rear-driving safety that the vibration was severe was no doubt very largely owing to the fact that the earlier machines were

badly designed, and encouraged the rider to lean forward with his weight on his arms, but now that the handles are brought back nearer to the saddle, and may be raised to a convenient height, the muscles of the arms can be relaxed, in which condition vibration is very much less felt than if they be held rigid. The vibration which affects the handles arises principally where the front wheel touches the ground, as the connection is much more direct with the front wheel than the back, and the further the handles are behind this point the more the vibration is diminished, so that the advantages of having the handles well back are two-fold in this connection. In a spring fork the lateral rigidity of that part of the frame is greatly diminished, so that when one is used the top of the wheel is very liable to scrape against the sides of the fork when turning a corner. Spring heads and handle-bars involve more or less complication in the brake, and in all three there is a risk of interfering with the steadiness of the steering. Still, the hands are at present at a disadvantage compared to the body, as the latter has the saddle spring to rest on, and we think a simple anti-vibrator might be introduced for the front wheel with advantage, especially as the front wheel is pushed over obstacles, while the back wheel is drawn or "trips" over them. As to the pedals, it is not desirable that there should be much give about them, as it is through them that the rider's power is first transmitted to the machine, but it fortunately so happens that when the most power is being exerted on them—on the downward stroke—is the time when they are in the best position as regards vibration, midway between the two points of contact. Rubber pedals should here suffice.

A spring frame should be as strong to carry the weight, as rigid to withstand the driving power, as free from complication, and as light as its unyielding opposite; further than this there should be no variation in the distances between saddle, pedals, and handles when working. We need hardly say that no anti-vibrating machine at present on the market fulfils all these requirements. The simplest have some variation in one or more of the distances between the parts above mentioned, the wheels are rather apt to get out of track, and there is at least one joint which requires to be kept constantly up to its work. The more complicated frames, perhaps, enable their object to be carried out more fully, but they have more joints to be prevented from loosening and rattling, and, if not heavier, are less rigid and weaker, for, though the nature of the frame may allow of some of the parts being made lighter, the saving in this direction is usually more than outweighed by the added portions.

Anti-vibration spokes have been made both corrugated and with their centres twisted into a spiral spring; the former answered very well, we believe, the latter probably give too much sideways. We do not consider either of them suitable for driving wheels.

WEIGHT.

There is a good deal of misconception on this subject. No doubt a light object is moved by extraneous force easier than a heavy one, but a cycle is moved by force transmitted partly through itself, and unless the machine be rigid in the parts concerned, there will be a loss of power in the transmission. A very light machine may carry the weight of even a heavy rider without breaking down, but when it comes to hill-climbing the light frame will spring and absorb the power, where a heavier one would be rigid, and the power be utilised in rotating the driving wheel instead of being wasted in bending the frame; so it is not entirely or perhaps so much how light a machine will carry the weight of the rider, as how light a machine will withstand the driving power of the rider. Some light men can expend more force than some heavy ones. If the weight of the machine is to be reduced in the frame, the tubes should not be much reduced in diameter and gauge without compensation being made by shortening them as well. This involves smaller wheels. The smoothness or roughness of the road surfaces, the presence or absence of hills, and the care of the rider for the machine, all influence the weight of the machine—*e.g.*, an old rider will spare his machine over a rough piece of ground, riding lightly in the saddle, and putting more weight on the pedals; whereas a clumsy, inexperienced rider will bang through everything, and should be provided with a stronger, and therefore heavier, machine than the old rider. But the very freedom from danger of the rear-driving safety bicycle leads to its being ridden more roughly than was the ordinary bicycle, and in the general way it must be built stronger to withstand the severer usage.

Then, again, a modification in, or addition to, a machine may more than compensate for the accompanying increase of weight by attaining some other advantage. Some may at first sight feel inclined to doubt this, but it has been amply demonstrated by the pneumatic tyre, which, with its rim, is much heavier than the "bootlace" solid tyre and rim that it succeeded, but by its vibration-destroying powers added perhaps ten per cent. to the speed of the cycle. In a less degree it is true in a practical way of the gear-case, which, by keeping the chain clean and allowing of its proper lubrication, saves a very appreciable amount of friction in the driving gear.

Theoretically, under perfect conditions, a heavy machine should not run faster downhill than a lighter one, but as the heavy machine does not generally present an increase of surface to the resisting air in proportion to its increased weight, and as the greater weight more readily overcomes the obstacles to its progress, the heavier machine will usually run faster and farther downhill than the lighter one, other conditions, of course, being equal.

Do not boast of the weight of your machine until you have tested it on the scales. We regret to say that you are almost certain to find it more than you either thought or wished. But, as we have shown, weight is not always a disadvantage.

CHAPTER II.

RIDING.

LEARNING.

THE learner will be wise if he tries to realise the fact that, even if he does know something about it, older cyclists know a good deal more, and it is better to profit by their experience than to buy it dearly for himself.

A friend is very useful in helping to teach with a tandem tricycle or safety, in correcting mistakes, and giving hints as to oiling and other points—small in themselves, but nevertheless very important.

We think it is best to first learn the action of the pedals on a tandem tricycle or safety bicycle, the other rider having sole charge of the steering, your handles being fixed. Then have your handle-bar connected to the steering, but let him continue to control it; this will show you how little movement is required. Next take entire charge of the steering. Now lead your single safety to a slight hill (say one in forty gradient), wide, good surface, unfrequented. Leading the machine will initiate you into the steering a little, walk on the left side holding it upright by the handles, take care that your right leg is not struck by either the pedal or step, and that your clothes are not soiled by the chain, if that be on the left side. Don't wheel the machine too close to the kerb or the pedal will strike and get damaged.

Prevent the machine leaning far away from you or from crossing your path, or it may fall and pull you over on top of it.

The machine can be stood against a kerb or other suitable object by resting one pedal on it; if the road is on an incline, the pedal should point down the hill rather than up. Do not let the machine lean more than necessary, as its weight will cause it to revolve the pedal and let it fall down. The front wheel should turn towards and touch the object if possible; if not, let it swing round towards the side the machine is leaning to.

It is difficult to lean a safety against a wall without chaining or tying, so that it will not slip down, owing to the handle slipping and the front wheel swaying round. Cork or rubber handles are less liable to slip than horn or wood. In the absence of a steering-lock, the best way is to tie or chain the front wheel to the lower backbone or corresponding part of the machine. This prevents the wheel swaying round or the machine being ridden.

When it is desired to leave the machine standing, and there is nothing to rest it against, it may be turned upside down, and stood on the saddle and handle-bar. The lamp should be previously removed, and the bell and handle-bar protected from damage from the ground or floor by a pad. Keep the front wheel straight, or the machine may fall on its side.

These little pieces of information will come in handy during the periods of rest between your efforts.

Arrived at the top of the hill, take off the pedals and let the saddle down so low that your feet can touch the ground when you sit on the saddle. Take hold of the handles, and with a slight push from the feet start the machine down the hill; keep the feet off the ground as long as you can, only putting them out to save a fall. Do not go too fast, but on the other hand do not simply crawl, as it is much more difficult to balance at a slow pace than when the machine has acquired some momentum. When inclined to fall to the right, turn the front wheel a little that way, and *vice versâ*, thereby bringing the centre of gravity under your weight, and restoring the equilibrium.

This is strongly against one's natural inclination, but so soon as the tyro has found it true he promptly proceeds to overdo it, and a tendency to fall to the right is straightway converted into a liability to come to earth on the left, and so he wobbles more and more till he does come down.

At first, very likely, you will feel as if it were an utterly impossible thing for you ever to ride a bicycle, and the temptation to give it up in despair will be very strong; but faint heart ne'er won fair lady, and we think you will admit that you ought to have as good a chance of learning as some of the effeminate creatures one sees on machines. Think, too, of the pleasure to be derived from this field of sport after the gate has been unlocked. We remember how despondent, nay disgusted, we felt when we began learning on that old boneshaker, and we know how thankful we are that we persevered.

Just as with a hoop, the faster the machine travels, the more easily will it balance.

The wind, if any, should be at the rider's back, otherwise a still day is to be preferred for learning, as it tends to upset the balance when blowing broadside on.

If you have confidence and circumstances are favourable, you will soon be able to go a hundred yards or so. Have plenty of pluck, don't get in a flurry, and don't expect to learn all at once. When you can go right down the hill in this way, try to go down standing on the step. Stand behind the machine, grasp the handles, put the left foot on the step, and lean the machine slightly to the right. When you feel steady, take two or three good swinging hops with the right foot, raise yourself on the step, and try to go as far as you can balancing in this way. Next, put your right leg forward by the side of the saddle, and then sit right on it, and as soon as settled take your left foot off the step, and let both feet hang down nearly straight. To get off, reverse the above manœuvres, or wait till the machine is nearly stationary, and then put out your foot towards the side you are falling to. The first is the better way, and should be mastered as soon as possible. If the saddle will not go down very low, one must begin by learning to balance on the step. On no account attempt to dismount by slipping off the back of the saddle. It is most dangerous.

If in the above exercises you lose your balance, and have to seek *terra firma* with all speed, take care not to drop the machine; there is not the least need to do so, but the habit of doing so is more easily acquired than got rid of.

The reasons for removing the pedals are that they may not catch the feet of the rider, and that they may not be damaged by falls. Now raise the saddle to a comfortable height and replace the pedals, setting the pedals at the same length in the slot as you had them on the tandem. Mount as before, and when fairly going try and find the pedals, letting your feet rest on them as lightly as possible. Don't attempt to work until you are thoroughly accustomed to the motion, or it will upset your balance. If you wobble very much remove your feet until the balance is regained. After some practice at this try and keep yourself going when the machine begins to slow down. When you can go, say, fifty yards further than you used to when the pedals were off you may honestly say you can ride.

Turning is accomplished by both steering and leaning a little in the direction you wish to turn. Don't do either too much, and don't forget to keep on pedalling or you will die for want of breath.

The novice will find that every vehicle he meets will act as a powerful magnet, and an almost irresistible impulse will seize him to cast himself under its wheels, and until he feels more at home in his new position he had better get off till the trap has lost its fascination.

It does not take more than six or eight hours to learn the balance as a rule, but there will be plenty left to learn after one hundred miles even have been ridden.

We think it is better on the whole to learn on the road, as riding in a school is a very different thing from performing in public. Don't attempt too long rides at first. Ride about in your own immediate neighbourhood, so that you can go home directly you feel tired. It takes a considerable time to develop the muscles, and overwork should be most carefully avoided. Try and do a little better ride each time you go out, and you will soon improve.

Do not give people the idea that cycling is a refined species of hard labour; ride comfortably, and with at least the appearance of ease, especially uphill. It is wonderful how real this make-believe appears, even to the gay deceiver.

Pedalling and Position of Saddle and Handles.—We have tried in this book to treat each subject separately, but these are so mutually dependent that we must take them together to do anything like justice to either. The correct method of pedalling and the best positions of the saddle and handles are becoming settled, but their relation to each other has either not been seen, or, if seen, not so appreciated as to be thought worthy of much notice. If the saddle be too high, the steadiness of the steering will be interfered with, and the rider will, besides losing control at the bottom of each stroke, be liable to injure himself; if it be too low, he will be cramped at the top of the stroke, and thus be liable to back pedal.

To ascertain the height at which to fix the saddle, loosen one crank and let it hang right down; turn the fixed one down too, then get on the saddle, and when you can just reach the pedals comfortably with the hollow of the feet, fix the saddle at this height.

As to the horizontal position, the saddle should be so placed that a line passing from the crank axle through its centre would make an angle of about 20° to 22½°, with a line rising perpendicularly from the crank axle. If the rider be abnormally long or short in the hip, the angle may be increased or decreased accordingly, and as a rule the saddle should be more forward for heavy work, especially hill-climbing, and further back for light, quick work, such as racing. Some saddles have more nose than others; calculate the centre with regard to the part that you sit upon. Now mount again, and see if you can still reach properly; if not, lower or raise the saddle till you can, and then make all secure. Set the handles so that when the rider is sitting upright the arms are *almost* straightened. The elbows should be kept close to the side. Remember the saddle is provided with a spring to carry

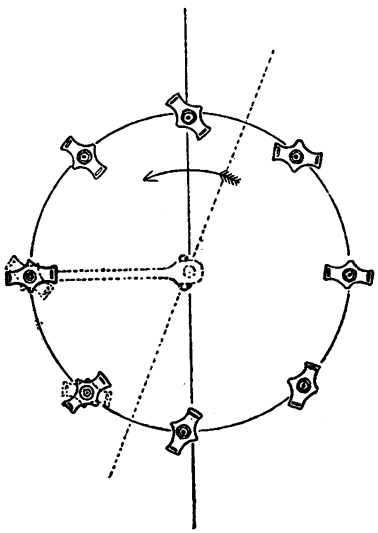
the weight of the rider. The handles are to steer with, and be pulled at, not to lean on, and should be placed well back, as the rider gets great assistance by pulling at the handles in hill-climbing. The proper position for the (centre of the) handles is about vertically over the crank axle. This is not so far forward as to draw the rider out of the saddle when pulling up hills, etc., and it is sufficiently far forward to provide the horizontal resistance necessary in "ankling" over the top "dead point." The pedalling had better be learnt first on the tandem, as on the bicycle the beginner will find all his attention required for balancing and steering at first. It is well to learn to pedal properly as soon as possible, as there is no advantage in acquiring bad habits only to unlearn them. There are three ways of sitting on a cycle with respect to the driving thereof: First, the rider may sit far back, as on the old boneshaker and thrust; or secondly, place the saddle vertically over the crank axle, and plug, *i.e.*, drive with short, sharp downward strokes; but thirdly, the best position lies midway between these, and combines the advantages of both. The old notion of getting right over one's work is found to be incompatible with the proper use of the ankles, and it throws the rider's weight too much on to the narrow part of the saddle, and it (the saddle) should be gradually moved back to the right point. The consequent improvement in comfort and the driving will be very noticeable in most cases.

Theoretically a rider should be able to apply power through half a circle without moving his ankles, but practically he will not do so through more than one-third. The uninitiated tyro at tricycling soon finds that there is a dead point in the pedal circle at which his power is of no effect: if he gets one pedal about vertically over the other he may press his feet down for all he is worth, but the machine will not stir an inch. Now, if one could apply power equally all way round the circle, it is obvious that it would take only half or one-third the power that would be necessary to produce the same result pressing through only half or one-third of the circle. If the rider had to drive the machine with his hands instead of his feet he would not give the pedals (or, rather, handles) short pushes, but would keep up an even pressure all the way round, as this would not call for such a high tension on the muscles, and there would be no dead point felt. The action of the hands can be imitated to a very useful extent by the feet if the ankles are properly availed of, and the cyclist who uses these joints when pedalling will be able to ride faster and stronger than more muscular men who do not do so, as he will be able to apply power through about two-thirds of each revolution, producing an increase of about twenty-five per cent. in power and neutralising the dead point. To secure these

advantages, the saddle must be fixed in the right position, and the feet be properly placed on the pedals. The shoes should have the soles fitted to the pedal bars, so as to bring the ball of the foot over the centre of the pedal, and the inner sides of the feet parallel to one another. On no account ride with the pedal under the instep!

The heels should be turned out a little, if anything; the rider will soon learn to do this if he catches his ankles on the bosses of the cranks a few times. He should not press more on one side of the foot than the other. The knees should be bent in a little—in fact, a front view should show the knee joints working perpendicularly over the ankle joints and without any twist in action.

The accompanying illustration represents the course taken by the pedal pin, and the correct positions for the pedal at the various



points when revolving in the direction indicated by the numbers, and the dotted line across is supposed to be produced from the hip joint through the axle.

The ankle joint is controlled by the muscles in the shin and calf; the knee joint by the muscles in the thigh, and the hip joint by other muscles still higher up. It is an easily verified fact that when a person is standing the ankle joint allows the foot to be bent

downwards very much more than upwards from the horizontal. With practice the joint will give and the toes can be raised a little higher, but the proportion will not be materially affected.

It is desirable that forward pressure should be applied as soon after the pedal rises above 8 as possible, but the higher it rises the more the knee is bent and the less the toes can be raised, so that if this power is to be applied before the pedal gets to 2 the saddle must be put back so as to get behind the pedal; on the other hand, it must not be put too far back, or the rider's weight will become of less effect as a resistant to the power of the leg (a weight being more easily moved in a horizontal than in a vertical direction), and the stroke will not be finished properly. We will suppose, then, that by raising the toes as far as possible and wearing fitted shoes, the rider will be able to press the pedal forward and upward by the muscles of the thigh and body to 2 and on to 3, the power increasing as the position become less cramped, the heel being still dropped.

From 3 to 5 is the part of the stroke at which the power is most effective, being most nearly at right angles to the resistance, and this part may be worked in two ways: For light easy running the quicker though weaker muscle of the calf may be used, the knee being kept comparatively still, and the toes quickly dropped (as indicated by full lines), the pedal being driven by a smart pat, so to speak; but for hard work it will be found best to keep the heel down all the way to 5 (as indicated by dotted lines), the more powerful muscles being retained in action. In either case, on leaving 5 the toes should point downward, and the pedal be clawed back as far past 6 towards 8 as possible; we will suppose this point to be 7. This is a good deal further behind the hip line than 1, because the bending of the knee, though comparatively slight here, instead of preventing the sole of the foot from assuming a vertical position, helps it to do so.

Clawing is done more easily if the knee be bent than if the leg be straightened, hence the advisability of being able to reach with the sole of the shoe a point much lower than the top of the pedal at its lowest point.

The position of the saddle here again becomes important, as if too far back the rider will not be able to "claw" much past 6, and if too forward he will be very liable to hinder the pedal rising above 7. Directly the rider has ceased to apply power in the right direction (say at 7), he must nimbly raise the toes, most carefully avoiding all resistance to the rising of the pedal until position 1 is reached again, this part of the stroke being principally worked by the muscles of the calf.

The most casual observer will see how much more powerful this action is than the piston-like plunge of the rider who drives from somewhere between 2 and 3 to perhaps 5.

The action, especially the pushing and clawing, may be practised indoors with advantage on a home-trainer provided with a brake. Practise the less skilful leg first, and have a mirror at your side so that you can see that you are doing it properly. In riding on the road you can often watch the shadow of your feet, and see whether you are ankling properly. Shortly, the expert rider uses his ankles more, and his knees less, than the novice. Do not attempt to ride fast or hard until you can use your ankles properly.

Back pedalling, that is, resisting the revolution of the pedals, is very useful in checking the running of the machine in traffic, or as an aid to the brake downhill. The action should be the reverse of that just described. The knee should be raised, the toes lowered, and pressure applied backwards from 1 to 3, downward pressure avoided between 3 and 5, the heel dropped between 5 and 6, and forward and downward pressure applied till 7, and downward (the heel being still dropped) till 8 is passed, and 1 reached again. Never press on the pedal as it rises, unless you wish to retard the machine.

Having shown how to master the rudiments of the art of cycle riding, we will deal with a few special points that are sure to thrust themselves forward sooner or later. First we may give a few hints on

STREET RIDING.

Bicycling in the streets of cities and large towns is not nearly so dangerous as it appears to on-lookers, but it should never be practised by the novice or the nervous, nor when the streets are wet unless the tyres are provided with really effective non-slippers. To some, it is a matter of economy or convenience to use the safety as a means of transport from home to office, and to such we offer the following hints: The rider must be thoroughly expert, and complete master of his machine; the machine should be provided with a powerful hand brake, and be geared low, so that the pace may be slackened or increased promptly. The saddle may be placed so low that the rider can stop and put his feet to the ground without dismounting. The rules of the road should be strictly adhered to. Before commencing to overtake a vehicle try to see through it what is coming the other way; many omnibuses are now made with glass in front, making them practically transparent. If you cannot see through, bear out to the right at such a distance behind the vehicle that you are about to overtake that you can get back behind it if necessary; if you turn out sharply you stand a good chance of being bowled over by something coming the opposite way. Omnibuses are bad to ride behind, as they stop very suddenly, and you are likely to collide with passengers getting on

and off; the first objection does not hold good with London expresses, but the latter does. Hansom cabs with passengers in are good to follow, but take great care of all cabs plying for hire, as they have a knack of turning out suddenly across one's path.

Shop windows are particularly useful in towns, for by looking at those at your side you can see reflected what is coming behind, and, as you approach a cross street, the windows you can see in that street reflect what is coming up it to your road. If you wish to turn off to the right or left, signify your intention to anyone following by holding out the corresponding hand. If you wish to slacken speed or stop, hold up one hand. Do not ride too close to the foot-path, and keep a sharp look out for people crossing and about to cross the street. When meeting or about to overtake any pedestrian who is evidently unaware of your approach, give warning as inoffensively as possible. If your path crosses his, steer behind him rather than in front. Children should be treated with great caution; they are only less difficult to deal with than old women. We can give no definite advice as to the latter, the fickleness of their youth is evidently exaggerated in proportion to their years; perhaps the safest thing to do is to ride straight ahead, as, if negotiations are attempted, they generally do just what one does not expect. Old women are usually harmless in their intentions, children are not. Do not be beguiled into riding over that harmless looking hat; there is as likely as not half a brick under it, but jump off and take the hat away with you, the child is sure to get a punishing at home, both for the loss of the hat and for the reason of it, and the caps make excellent scare-crows. If a child misbehaves in some other way, a good spanking will often do more good than a reference to parents or police; remember it is not a case of revenge merely, but the safety of other riders.

Vicious dogs will usually turn tail if the rider slackens his pace.

The safety bicycle is at its worst on greasy surfaces, for the weight of the rider being low down there is more risk of side-slip than on a taller machine. When a greasy stretch is encountered, lean forward so as to distribute the weight more equally over the two wheels, steer as straight as possible, holding the handles firmly, and pedal evenly. If the road cambers much keep in the middle, and if the traffic won't allow this, get off quietly; it does not do to risk a fall in traffic.

When asphalt, wood paving, or setts are quite dry or thoroughly wet and clean they are safe enough to negotiate, but not otherwise. Tram-lines are generally laid in stone setts, and are often very greasy owing to the lines being watered to facilitate the running of the cars. Beside the danger of the

greasy mud, the roadway often wears away very much at the side of the setts; where this is the case, and it is desired to cross the track, a spot where the road is least below the setts should be noted, and a good sweep be made across the lines. Do not apply power when on the grease, and keep as straight and upright as possible. Sometimes the horse-track is better running than the road; if you wish to try, cross into the middle as if you were going to cross the track, but sweep round just before you reach the second line. Of course, do not attempt it if the setts are greasy.

Dry tram-lines, if level with the roadway, afford good going for pneumatic-tyred machines, but unless the lines are disused there is a risk of puncturing by small splinters of metal. To save the machine, the body should be raised from the saddle, and the weight carried by the pedals, when passing over very rough ground, such as badly-laid street crossings. Finally, the rider must be prepared to back-pedal, to put on the brake, and to dismount at any moment. Riding at a moderate pace, even through traffic, will be found a good preparation for business, but the benefit will be lost if one hurries.

Sticks, etc.—If you cannot steer out of the way of a stick, ride over the middle of it; if you go over one end it is liable to turn over and, catching in the wheel, break the spokes.

If there are deep ruts in the road, keep out of them, for even if wide enough to ride in, the pedals may strike the ground. If you get into one, and it is not very deep and fairly wide, do not be over-anxious, but ride straight on until you you see a good chance, then steer out, holding the handles firmly and shifting your weight off each wheel as it strikes the edge; if the machine begins to skid, either turn back into the rut or dismount; in either case act at once.

In contact with patches of newly-laid stones, the safety shows its good points; the machine can be ridden right through if necessary, or along narrow spaces at the sides. It is not wise to ride over stretches of new stones, as it strains the machine, cuts the tyres, dents the rims, and is uncomfortable to the rider.

Meeting Horses, etc.—If a horse shows signs of restiveness, approach it very slowly and with the bell silent, and speak to it soothingly; some find comfort in being whistled to. If it becomes advisable to dismount, glide off as smoothly as possible, keeping between the machine and the horse, or even put the machine in the ditch out of sight. It is a good plan to get the horse to sniff the machine over a bit, and so get better acquainted with it. Cows and some other animals have a knack of standing still until the very last moment, and then turning away; it is a good plan to ride quietly up until pretty close to them, and then ring your bell or shout, and they will scamper off.

Get off when meeting or overtaking flocks of sheep, &c., unless there is evidently plenty of room.

Carters.—You may yell at some of these men till you are hoarse, without effect, but if you call "Whoa-way" to their horses the carters will hear at once; some of the horses, too, have the sense to get out of the way at the same time.

Roads Generally.—The smoothest going is generally at the sides, but on some limestone roads the horse-track is the smoothest. Gravel roads are better than macadam in dry weather. It is often worth while to notice the tracks of any cycles that have been over the road before, as they may show the best part of the road to ride on.

Footpaths.—Never ride on the path; it is illegal, and very reasonably so; besides, it brings the sport into disrepute. However, if you do find yourself on the path, take care how you get on the road again; if the path be narrow and kerbed it is best to dismount and lift the machine off the path, but if wide and sloping gradually to the level of the road make a sweep so as to ride off nearly at right angles. When riding along a path take special care of gates and other openings, as something may rush out and upset you—a policeman, for instance. Look out for low branches of trees and other such obstacles.

Night Riding.—Next to early morning riding, when the air often seems like champagne, the most enjoyable time for cycling is in the dusk, after the heat of the day. A ride in the evening has a charm all its own; the machine spins along with inappreciable effort, and one feels that any speed is possible. As the twilight deepens and darkness comes on, level roads seem to decline, and fairly steep hills are climbed almost before one knows that they are reached. This may appear like romancing to the non-cyclist, but practised riders know from experience that it is fact. What the eye does not see the heart does not grieve for, and, accordingly, the little difficulties and obstructions that engage the mind in daylight being unnoticed because invisible, the system does not waste and become suffocated so rapidly. Riding in absolute darkness, however, is not pleasant, and it should never be practised, if avoidable, on unknown roads. There is considerable danger of collision with other vehicles. Cycle lamps are usually more useful in indicating one's position than in illuminating one's path. Other users of the road always seem to think that you can see them as well as they can see, not you, but your light. One could often see better without the lamp, especially in fogs, when the light simply sets up a white curtain just a few yards in front. The ears should be kept actively on the alert. The first thing to detect on hearing the sound of a vehicle is its direction of motion. Slowly moving wagons are often very deceptive, and one sometimes cannot tell

which way they are going until nearly on to them. Passing other vehicles, whether meeting or overtaking them, should be effected with the greatest care; if meeting, do not return to the centre of the road until well clear of, not only the conveyance, but also its noise, as it may be followed closely by a second, or more, the sound of which is drowned by the first. The second driver in following the first is apt to be careless, and even if most careful it might be quite impossible for him to avoid a smash if you steer into his path. Of course, all drivers should show lights at night, but far too generally their consciences carry them no further than the law's requirements, which, unfortunately, do not, at present, include "universal lighting." Strings of pleasure brakes, especially, should be given as much margin as possible; it is often better to dismount till clear of them. In overtaking, make certain, so far as possible, that nothing is coming in the opposite direction to block the passage.

HILLS.

The man who begins to cycle forthwith discovers that his neighbourhood is of a far hillier description than he ever had any idea of. Roads that he regarded as perfectly level before assume the form of miniature mountains. The least rise becomes perceptible to the novice, and the climbing of it, at first, an almost impossible task. A little practice, however, soon makes a vast improvement, and, after a time, the country resumes its former physical aspect. Strange hills have a knack of looking much worse than they really are, when viewed from the top of the preceding hill, but it is merely an optical delusion, which fades away as the difficulty is approached. Hill-climbing is rendered easier by not paying too much attention to the inclines, as is evidenced when riding with companions, or in the dark. If a hill is at all stiff it is bad to keep looking at the top; the eyes may well be turned towards the feet. See that the heels are kept down well to the end of the stroke, and be very careful not to press the pedals as they rise; we believe this is a much more common fault than is generally supposed, especially when pedalling slowly and hard. Short inclines may be rushed, and it is generally better to keep up a considerable momentum, but sometimes one can get up a hill comfortably by going quite slowly and without any flurry. One is less likely to back-pedal then, and probably there is less suffocation arising from rapid waste of tissue. For ordinary climbing the body should be inclined forward from the hips so as to bring the muscles of the trunk into play, and the saddle and handles should be conveniently placed, neither being too far back. Nearing the top, or for a change on a long hill, one may sit straight up and pull at the handles, but this, the pet position of theorists, cramps

the lungs and "blows" one so quickly that it cannot be retained long. Do not forget to breathe fully and freely while making ascents.

Don't bother to ride every hill you possibly can, but, on the other hand, don't get off for every little rise in the road, as constant mounting and dismounting wastes a lot of time, and is tiring in itself. As a rule, ride as far up a hill as you can until the exertion threatens to become excessive, then get off.

Downhill.—If the climbing of hills is difficult, the descent of them is dangerous. At first, the sensation of running along without effort is delightful, but as the pace increases, the pleasure diminishes, and, almost before he can think, the novice finds himself mangled in a mass of metal and, maybe, mud. Therefore, let the proper use of the brake be one of your first accomplishments, and do not be afraid to practise it whenever occasion arises. As experience makes you more familiar with your steed, you may take more liberties with it, but at first you must ride according to rule. Some riders never cease to be nervous when descending hills, and always keep well in hand; they are on the safe side, but those who enjoy a "coast" are in the majority. Many a time and oft has the novice been cautioned against travelling at a high speed down unknown hills. The caution is perfectly sound, but it might well be supplemented by a little advice as to what to do when the rider is desirous of stopping his more or less mad career along the downward road. When a cycle is travelling fast no brake can be expected to pull it up dead in a yard or two; it would be hardly fair to put such a strain on any machine, and the sudden check to the momentum would probably unseat the rider. On most occasions the application of the brake should be supplemented by back-pedalling. The pedals are, in this position, well under the weight of the rider. Few cyclists, unfortunately, will take the trouble to learn the theoretically correct action of back-pedalling, and the safest course when putting on "full speed astern" is to slip the feet forward on the pedals until the back bars come in contact with the fronts of the heels on the shoes, from which position there is small chance of the feet slipping or being jerked, however much reversing power be employed. If the practical reader, in trying this, finds he cannot comfortably reach the pedals he may be certain he is riding too high, and may lower his saddle until the difficulty is altogether removed. Flying or coasting a hill with the feet on the rests is delightful and exhilarating. Some find it restful, others, mostly "scorchers," find it stiffens them. In cold weather it may become dangerous on account of the liability to contract a chill while heated, maybe, from ascending the other side of the hill. Straight, moderate declines, without cross roads or other openings

for the rapid approach of obstacles, may be negotiated at a good speed with safety and advantage, but the rider should never lose his head nor the reasonable control of his machine. If his steed should begin to get the better, or rather worse, of him, the best thing is to jump off at once. Probably, the best way is to spring back from the pedals and handles, with the knees well straightened, so that the body does not come in contact with the back guard or tyre. Take care not to let the machine cross your path as you run, after dismounting, or you may get an awkward fall over it and damages all round. Should the pace get too fast and furious to attempt a dismount, apply the brake as hard as possible, though gradually; place the inner side of each shoe on the tyre in front of the head, and press hard; this constitutes a very powerful brake. If there be no mud-guard on the front wheel, the soles may be applied to the tyre behind the head. Further, steer through any sandy patches or heavy going, provided it be not greasy. Take all curves with wide sweeps, cutting close to the projecting corner. If these manœuvres fail, and there is nothing in the way, steer a straight course to the bottom, and be thankful if you arrive safely. If there is no choice but to run into something, choose the softest and least expensive obstacle possible—a hedge or a grass bank for preference. A safety having a good brake and a good rider should never run away; failing the brake, "back-pedalling" or the foot on tyre should be resorted to, but failing the good rider—!

Wind.—A cyclist and his machine present a considerable surface to the wind not only fore and aft, but sideways. In riding at a certain pace in still weather the cyclist has to put forth an amount of power equal to that which would just prevent his being blown in the opposite direction by a wind travelling at the same pace, so that there is always a certain amount of atmospheric resistance or wind to be contended with unless it be travelling in the same direction as the rider, and at least equally as fast. A non-cyclist would probably be surprised at the amount of resistance a contrary wind offers to the wheelman's progress, though it is less felt on a rear-driving safety than on any other type of machine, and he would certainly be surprised to find that a side wind produces much the same effect. The explanation of this fact we are not quite sure of, but we are inclined to think that it is owing to the bearings of the wheels being more or less jammed by the side pressure; the wind has a tendency to force the rider's body and the frame of the machine along in its direction, but the wheels are prevented from going by their grip on the road, and they, through the bearings, which form the connection between wheel and frame, etc., prevent the frame and rider going. The rider has to lean against the wind, too, and this may prevent the

free progress. The retarding effect of a side wind may sometimes be diminished by twisting one shoulder a little forward so as to get the wind on the back, thus, if the wind be blowing from the right, turn the right shoulder forward and *vice versâ*. Except in a very heavy wind, we do not know that tacking across country is much good, as one has to go about twice the distance to materially reduce the resistance. In riding against the wind, the body should be bent forward so as to present as little surface as possible; it is not an elegant attitude, but it is the most comfortable, for a time at any rate, under the circumstances. On a ride of any length, it does not pay to battle with every little stormy gust; it is much better to let the pace drop for a moment, while it spends itself. Sometimes one has to contend against a pressure of air so even that the leaves hardly stir on the trees, and one is puzzled to know why the riding is so hard. When starting for a tour, or even an all-day run, it is best to set out with the wind behind; one is sure of it then, and it is quite likely it will die down before the return journey is commenced.

CHAPTER III.

TOURING.

IN order to enjoy cycling to the full and to appreciate one's machine, one must tour. Preparations should be made some time beforehand. He who is not a member of the Cyclists' Touring Club* should forthwith apply for admission. Longer distances than usual should be practised until sixty or eighty miles (or a good deal more than you mean to do in a day) can be covered in the day, without over-fatigue. Practise hill-climbing also, especially if about to go through hilly country. The route being decided on, the Chief Consuls of the respective districts should be written to, and a description of the roads obtained, unless the district be covered by the Club Road Book, which should be consulted instead. The information thus obtained should be amplified by notes of objects of interest to be seen, particulars of which can be found in guides and gazetteers. The memory (assisted by photos taken or bought) of a tour is sometimes even more pleasant than the actual experience, and the more incidents there are in the tour the more interesting it will be to recall and recount. By-the-by, your recollections will probably not be very interesting to your friends, except those who have ridden over the same ground, and, above all things, do not tour with the object of being able to boast how many miles you covered each day; your record may be cut even before you get home. If your vanity must be gratified, do a long ride home on the last day; this will be more easily done, as the roads will likely be well known to you, and your friends better able to appreciate the distance. If you are knocked up so much the better; pride must have a fall.

Any structural defects in the machine should be repaired before you begin getting up your distance riding—three weeks or so before you start. A day or two before the eventful morn, carefully examine the machine by daylight, especially look out for loose bearings, nuts, and spokes, and defects in the tyres; these should all be attended to, the machine oiled up, luggage fixed on, and a short ride taken to see that all is in working order, then you will not lose time and temper in the morning fiddling about when you ought to

*See "Institutions."

be off. Neglect of these precautions may be most serious. Make up your mind to carry as little luggage as you conveniently can. Keep a piece of paper and jot down on it the things you mean to take when you think of them. It should read something like this: Machine, lamp, bell, cyclometer.

In Tool Bag.—Spanners, well-filled oilcan, an oiled and a clean rag, flaming lights, and inflator.

In Breakdown Bag.—A screw-driver, spare nuts, bolts, washers, spokes, links of chain, a spoke grip, tyre-repair outfit, copper wire, whipcord, a few dress hooks, slips of tin of various thicknesses; some wick, flask of lubricating and lighting oil, sportsman's knife, padlock and chain, and a waterproof saddle cover.

In Luggage Bag.—Spare day shirt, waistcoat (where it can be easily got at), bathing drawers, three or four linen collars or one celluloid, several handkerchiefs, sponge, tooth brush, French chalk in a strong box, comb, Testament or Prayer Book, C.T.C. handbook and maps, the last two carried in an outside pocket easily got at; needles, black and white thread, buttons, some court-plaster, and a tin of Homocea. The following may also be taken: Waterproofs (unnecessary if the clothing be all wool), hair-brush, trousers, extra pair of stockings, socks, very thin slippers, waterproof sheet, postcards or paper and envelopes.

A razor is an awkward thing to get loose in a bag, and one can get shaved in most civilised countries. We say "most" advisedly, for we found great difficulty in getting operated on in Ireland, and had a most truly painful experience under the hands of a barber who was "just making a start" in Bantry.

The several articles will pack much closer and be less liable to get mixed if rolled up pretty tightly and separately.

There are a number of little pocket cases sold, about two or three inches square, containing looking-glass, pocket comb, nail trimmer, and a book of soap leaves. These, when amplified with a needle and pieces of black and white thread, are capital companions on a tour, or even for shorter rides. The soap leaves are particularly useful, as one can have a refreshing wash under the pump in the inn yard without any fuss or bother; they are quite cheap, and one leaf is sufficient for each wash.

In Pockets.—Money, watch and key, details of route, fitted knife, chocolate, beef lozenges, Wyeth's tabloids (for curing thirst), and camphor pilules (the last three may be put together in a little tin box for the ticket pocket); matches and striker, pen and pencil.

Use a cheap, keyless watch when cycling—the loss of the key will then be impossible, and the loss of the watch itself less likely and of little consequence. Cycling does not seem to agree with all good watches. Don't carry a valuable gold chain, for obvious reasons.

The tool bag should be hitched on to the handle-bar, hanging down facing the rider. In this position it can be unfastened and fastened while riding; in fact, some little jobs may be done without getting off at all. Secure the bag so that it does not flop about.

The breakdown bag may be hooked on behind the saddle.

The luggage bag may be carried (1) on a frame in front of the head, over the front wheel; (2) on rests on the handle-bar; (3) between the head and saddle tube, above the backbone, if a single one, or between the backbones in a diamond frame; (4) behind the saddle; or (5) on the rider's back. With 1, 2, and 3 one can see what is going on (or rather off), 3 and 4 do not interfere with the steering, while 1 interferes with carrying the lamp in the best place, and makes the steering a little heavier, as does 2; 3 is apt to get in the way of the knees unless kept very narrow, which is difficult, and 4 is out of sight and interferes with the flexibility of the spring and pitch of the saddle.

The rear-driving safety being such an excellent luggage-carrier, there is no reason why the rider of this type of machine should carry the weight on his own person, as there was with the rider of the high bicycle. If properly constructed one forgets a knapsack's presence, but the relief felt on taking it off is most pleasantly noticeable; but every rose has its thorn, and if the rider takes off his knapsack when hot he may get a touch of rheumatism in his shoulders, as we have found to our cost.

Many prefer to wrap up their goods and chattels in a sheet of macintosh; the parcel made is then no larger than it need be, and the sheet is useful to stand on when the bathing accommodation at the hotel is limited; but one cannot get at anything without undoing the whole affair, which is not always desirable. A bag which has only one fastening to open or close, and that not a strap, is the handiest.

On the whole we prefer the second method (on the handle-bar), as one soon gets used to the steering. There are various styles of bags, each with special advantages, but it should be capable of adjusting to the size of its contents, so that the weight may not sway about, and also be easily get-at-able and detachable from the machine.

The bag itself is carried on two flat bars, called handle-bar carriers, which are clamped on at right angles to the handle-bar at about eight inches apart; they are provided with straps to bind the bag on with, and should carry a light platform, or have their upper surfaces covered with rubber, or they will likely wear holes in the bag. A piece of old rubber tyre may be bound on to each if no rubber is fitted on those bought. The luggage should not be allowed to hang over in front or behind, or it will interfere with the lamp or the knees.

No companion at all is better than an unsuitable one. He should agree in religion and politics, and be of about equal capacity in riding and purse. It is miserable to lag behind your friend, wearing yourself out trying to keep up, while you feel that the (slow to him) pace is monotonous, or to have to spend more than you can afford for sake of appearances. One is delightfully independent if alone, though a suitable companion is appreciated in uninteresting country or in case of a mishap, and little things that worry a solitary rider pass almost unnoticed when in company.

Unless the rider is in the habit of exerting himself in the open air before breakfast he had better dispose of his morning meal before starting, or he will likely be tired out by eleven o'clock. Take a good plain breakfast, then, at the usual hour, and give it a little time to digest. Take note of the wind, and if it will be more in your favour if you reverse your route—beginning at the end, so to speak—do so. If you have some miles of bad road to cover before getting on to the good roads, take the train out a little way, so that you get a fair and comfortable start. Start slowly, gradually get up to a moderate pace well within your powers, and then endeavour to keep to it. Ride up such hills as you can without over-exerting yourself, otherwise get off and walk; the change of exercise will be a comparative rest. Quick riding should be avoided as a rule, but some short hills are most easily mounted by rushing them. Avoid constant dismounting; it wastes a wonderful amount of time, though some riders find it a good plan to take a few minutes' rest every hour or so. The most restful position is flat on one's back, but mind you don't lose the contents of your pockets.

Full advantage should be taken of down grades by placing the feet on the rests, and letting the machine run. When in this position keep the knees close together, as it rests the legs more and keeps the heels out of the spokes. The machine should always be kept thoroughly under control by the brake, especially where the road is very steep, rough, or winding, or the bottom of it cannot be seen and is not known.

Hills which are too steep for the brake to hold the machine on, or the riding of which cause a great mental strain, should be walked. Those marked with danger-boards should be very carefully approached, as some are quite unrideable on any cycle.

Don't have rows with, or treat unfairly, other people using the roads. If they do not pay you out, they will the next cyclist they can. Politeness is very inexpensive, and kindness pleases all concerned. So keep the rules of the road; ride on the left (or "near") side of the road, and keep to this side when meeting vehicles, but in overtaking go to the right, returning to the left side when ten yards or more ahead. A horse or beast led by hand

should be met or overtaken on the side on which it is led, if there be room; this will often necessitate your going to the wrong side of the road. Though you should always keep to your own side, yet where a person acts indiscreetly you are still required to use ordinary precaution.

If riding with a companion, agree as to which shall ride to the left and which the right. When meeting vehicles, and there is only room for one to pass at a time, the one on the left should go first, and the other follow, and when overtaking, the one to the right should go first and intimate that another one is coming. When going downhill and you are behind, don't try to pass the other, and if you are in front keep to your own side and don't slacken speed suddenly.

Sit up and expand the chest. The mouth should be kept shut, both by day and night, the breathing being done through the nose, which organ is provided with "stoves" to warm the air, and hair-sieves to catch the dust. If the rider keeps his mouth open he will very soon get thirsty, he will draw dust into his lungs, and will catch flies, sore throats, and all manner of other evils. Some riders carry, or are supposed to carry, a small stone in the mouth, under the impression that it prevents thirst. This is quite true, for though one cannot get blood or any other more palatable liquid out of a stone, yet it is difficult to hold anything in the mouth when it is open, and so the stone helps to keep it shut. We would advise the substitution of something more easily digested—if it should go down—than the stone, however; say a raisin, which has considerable sustaining power in its small compass. Wyeth's tabloids and peppermint sweets may also be recommended.

It is often very difficult to know which way to take when a road forks. If there be no sign-post the point may be identified on the map with the aid of the cyclometer. A mile usually looks further on a map than on the scale, and a mariner's compass will show the general direction to be taken. Failing these, enquire of a native; he will most likely answer "straight on," but after a little time you will probably get the information required. In towns, ask a policeman or postman; they are less likely to play tricks than loafers.

If while riding you find yourself counting how many more miles you have to do it is a pretty sure sign that you are not thoroughly enjoying yourself. Carefully avoid planning out so much to be done each day; rather make it a hard and fast rule to stop when you feel tired, and, we may add, to eat when you feel hungry. Don't make a labour of pleasure.

Cyclists should always carry plain chocolate to be eaten when they feel at all faint and cannot get proper food immediately.

It assimilates very quickly, but has its disadvantages in that it induces thirst, is rather apt to cause biliousness, and has an unhappy knack of "going down the wrong way" if consumed while riding. We understand Cadbury makes a special brand for cyclists, but have not tried it. We have found Mason's beef lozenges very sustaining, and Bovril lozenges, like other preparations of the same brand, are good. These things are all very well in their way, but they are only temporary sustainers, and must not be allowed to do duty for a proper meal. You will probably feel hungry long before your usual dinner time. If so get off at the first place that will do (don't drag on for miles looking for a better), and get some bread and cheese and a few lettuces, or other green meat, will be acceptable. As to what to drink see p. 51. After a good rest go on for two or three hours more, and then you can repeat the dose or take an early "tea" (without actual tea, though). It is better to take two light meals in the middle of the day than one substantial one.

If a chop or steak be preferred it is sometimes worth while to send a sixpenny telegram to the hotel you propose to patronise, to have the same prepared, especially if there are several riders together.

Another two or three hours' riding will find you ready to stop for the night. Order a good meat tea; while it is being prepared see that the machine is properly housed, give ten minutes to cleaning it down, pay especial attention to the nickel and bearings, look for defects, and put the padlock and chain on, as some stable boys think "they can ride anything." For yourself have a good scrub down (a bath if possible), change as much of your clothing as you can, enjoy your meal, and go to bed about an hour after it. Do not give orders to be called at an early hour, but let Nature have her course, and sleep your sleep out. We avoid giving an actual time-table, as one of the greatest pleasures of touring is not to be tied to time.

It is much more healthy, and when, one is used to it, much more comfortable, especially in winter, to take off the sheets and sleep between the blankets. By sleeping between the blankets one saves all possible risk of damp sheets, so this course should be followed when on tour at any rate.

It is better to start one's day an hour or so earlier, if touring late in the year, than to ride in the dark.

The No. 2 shirt with the bathing drawers will make a decent night costume. The No. 1 shirt worn the first day may be aired and put in the bag, and changed into on the evening of the second day, worn during the night and for the third day's riding, after which the No. 2. will be put on again, the two being worn for each alternate twenty-four hours.

Handkerchiefs and stockings one can generally get washed at the stopping place for the night.

Clean things may be sent on from home to some place previously agreed on, and soiled ones returned in the same wrappings, an addressed label being enclosed with the clean things with that object.

Telegraphing.—If you have occasion to wire for anything, it is worth while spending an extra halfpenny or two in making your wants clear—the recipients are always extremely dense, and delays are aggravating, as well as dangerous.

The cost of touring varies with the requirements of the rider, but he can get a meat tea, bed, and meat breakfast and attendance at a C.T.C. hotel for about seven shillings, the two mid-day meals will come to about two shillings or two shillings and sixpence, so that ten shillings a day will about cover the living, including all day Sunday at a C.T.C. hotel. It can be done for a shilling or so less by patronising temperance hotels, which are frequently clean and quiet, and even less by going to coffee taverns or country inns. On the whole, we are not favourably impressed with coffee taverns; the food is almost necessarily second-class, and the liquids worse. If stopping in a town look out for a quiet temperance hotel; if in a village for a respectable inn. Tips have become a perfect nuisance. They are expected whether earned or not. We do not know which feels worse, to give or to withhold. In the first case you lose the money (which in the long run mounts up) in exchange for nothing, and degrade the recipient; in the other you are thought mean.

Some very compact and well-arranged spirit stoves are now to be had, and in fine weather one may take one's meals picnic fashion, buying eggs, bacon, bread, etc., at the village shop, and cooking and eating them at the roadside. Water can be got at from a cottage. As so many streams are polluted it is dangerous to drink from any unless assured of their purity. A combination of camping and touring makes a delightful holiday, given experience, a nice set of fellows, and good weather.

Touring on the Continent is rather cheaper than in England, so far as the hotels are concerned. Messrs. Gaze & Son's coupons are priced at two shillings and fivepence for meat breakfast or tea, three shillings and threepence for *table d'hôte*, and two shillings and tenpence for room, light, and attendance. They are available at a good hotel in almost every European town, and prevent extortion. Messrs. Cook & Son's prices are about the same.

A dip in a stream or pond on a hot day is very refreshing to most riders, though it has the effect of taking all the strength out of some, very much as if they had been got up with starch. How to get dry is rather an awkward question to solve, and if there be a spare shirt in the kit that is hesitatingly resorted to,

some run about till they get dry, but this is a proceeding only less dangerous in a civilised country than in an uncivilised. If your clothing is all wool, wipe off as much of the water as you can, and redress; you won't hurt, nor even if you have got involuntarily wet with rain, but if your exhalations are checked by cotton linings, etc., get your clothes dried at the first opportunity, what time you go to bed or lose yourself in the ample garments the landlord may place at your disposal. Take a good glass of hot grog before going to sleep, and the chances are no evil effects will result Avoid standing about in your wet things, even if they be wool, and don't steam yourself before the fire—you may want to go touring again some day.

Tourists should make the most of the many opportunities they have of leaving a good impression of the sport and its advocates. Some cyclists, decent enough fellows in themselves, seem anxious to assure their companions when touring that they are really utterly unprincipled cads whatever they may appear to be at home. If companionship prompts to such shallow-minded bravado and "showing off," by all means tour alone.

Don't tour on Sundays. We see no more harm in going for a ride on Sunday than going for a walk, perhaps not so much, but many respectable people, whose good opinion is worth having, think otherwise. Apart from this, the day's rest will be beneficial, and make riding on other days all the more enjoyable. If the tour be started on Friday or Saturday, the Sunday's rest will come when most valuable.

Thirst and Drink. It is a great mistake to drink much when riding. The more one drinks while riding the more one wants and the more one perspires. It is well to practise drinking only at meals, and that towards the end of the meal, and as little as necessary. Thirst may be avoided by keeping the mouth shut, washing the hands, arms, face, throat, etc., rinsing the mouth out with cold water, and gargling several times as deeply as possible. We consider lemon-squash (lemon-juice mixed with soda-water and a little sugar) by far the best thirst quencher. Soda and milk form a wholesome, refreshing, and sustaining summer drink, and may advantageously be substituted for coffee or tea at meals, though the latter is very refreshing to those who can take it. Tea is not a food, and is best left alone by most people. Good cocoa, properly made (we prefer Epps's), is very sustaining, and we have heard oatmeal water with a little lemon-juice very well spoken of. But the cyclist's drinks are almost as numerous as the Americans'. Here are a few:

Rum and milk.

Lemonade with two eggs beaten up in it.

Ginger beer from stone bottle and lemon-juice.
Hot home-made lemonade.
Lime-juice, citrate of magnesia, and water.
Egg and milk (one or two raw eggs broken into a tumbler of milk and whisked up) is very good, but, like milk alone, leaves the throat and mouth uncomfortable until rinsed out. A pinch of salt added to milk makes it much more easily digestible, and does not taste, unless the glass be drained.

Soda-water should be avoided by those subject to neuralgia.

Get into the habit of taking as small and as many mouthfuls as possible, instead of gulping the beverage down. Thirst arises from mild inflammation of the stomach. Hot drinks are more quenching than cold.

Bovril is a capital drink for keeping up the circulation on a cold or wet ride, but is not a thirst quencher; a little celery salt improves it immensely.

Accidents.—Every cyclist should attend a series of lectures on "First Aid to the Injured"—it is a duty one owes to mankind, and every reader who may not think so on reading this would do so if he were injured, and no one around knew how to help him, and still more so if it were a friend who were hurt, and he the one to look on helplessly. We cannot give full directions here, but we would just say these few things. In cases of ordinary fainting, keep the patient's head *down*—not up—and do not give him any liquid until he recover consciousness. When a man has had a smash, do not move him until you are certain he has broken no bones; disregard of this rule may likely mean amputation of an injured limb, or even loss of life. Profuse bleeding, especially if it come in intermittent squirts, should be stopped at once (it is sometimes a question of about two minutes) by direct pressure on the wound. In cases of poisoning, swallowing of large quantities of milk is always advisable; tea, eggs, and vegetable or animal (*e.g.*, sperm, olive), not mineral (*e.g.*, paraffin), oil may also be administered with advantage. Emetics should not be given if the patient's mouth appears to be burnt; otherwise they are invaluable. The simplest is to put the finger down the patient's throat.

We need hardly say that a doctor should always be fetched without the least delay.

These remarks are necessarily very bald, but they may prevent trifling cases being made very serious.

If cramp attack the rider, he should kick out vigorously, and if this do not cure it, he should jump off, and, keeping the muscle extended, rub it briskly. Never cycle without enough cash to carry self and machine home.

CHAPTER IV.

FANCY RIDING.

THE novice should aim at being a thorough master of his machine, and not be content with being able to get along "somehow." A little trick-riding will wonderfully increase the rider's comfort and confidence, and may be of great assistance in a case of danger.

Though acrobatic feats form no part of the amateur rider's necessary accomplishments, yet the practice and skill they require establish a confidence and mastership which are exceedingly useful in cases of difficult riding. How many riders are there who could mount on an open country road if their steps were broken or lost? How many could stand still on their machines for a moment even when hedged in all round by other vehicles?

The rider should make up his mind to do all his performances, when possible, from either side of his machine with equal ease, certainty, and confidence. The following different ways of mounting may be learnt with a little practice:

By the step: Stand behind the machine, holding the handles, let the machine lean to the right, place the left foot on the step, give two or three hops, which in time may be reduced to a mere push off, and raise yourself into the saddle. The same should be practised putting the foot on the step as you walk or run along.

Another way: Run along on the left side of the machine, cross the left foot in front of the right on to the step, give a good push off with the right, and swing into the saddle. This looks neat and easy when done nicely.

By the pedal: Put the left pedal just a little forward of the highest point, stand as in the first step mount, put the left foot on the pedal, give a slight spring from the right foot, lean the weight on the pedal, straighten the left leg, and pull yourself into the saddle by the handles. This should be done freely; it has the advantage that at least one foot is on its pedal as soon as the rider is in the saddle, so that no time or impetus is lost before beginning to apply power. Or, instead of standing astride the back wheel, keep on the left side of the machine, lean it rather more to the right, then proceed as before, swinging the right leg over the back wheel just as an equestrian mounts his steed. This also may be

done walking or running along. A little practice will be required to work the stride in with the pedal. This is a useful mount uphill.

The last two may be varied by bringing the right leg over the frame round the front of the saddle instead of behind. This is more suitable with machines having a single backbone than with a diamond frame. Take care the flap is over the right hip pocket, or it will very likely catch in the saddle and be torn.

Another way: Put the left pedal in the same position as before, stand astride the backbone in front of the saddle, and lift yourself upward and backward into position. This is very easy, but only adapted to machines with a low backbone, and the getting into position does not look well.

There is another pedal mount which is both difficult and a severe test for the machine. Instead of putting the pedal on the beginning of the down stroke, bring it so that it is at about the middle of the up stroke, lean the machine well away from you, put the left foot on the pedal (if it be the left one that is at the back, or the right foot if it be the right pedal), feel the balance of the machine, and with a light quick spring throw the disengaged leg over the frame and alight in the saddle. It requires a lot of practice to make sure of doing it every time, and if your machine is badly designed at the crank bracket will quite likely bend, or even break it, so it should not be attempted without due consideration. This is a mere trick, and almost valueless in itself.

Vaulting mounts: Stand across the back wheel, run along a few steps and spring into the saddle. This only requires a little pluck and skill. If this be practised as a standing mount, the pedals should be set so that the machine may be started directly the saddle is reached. It may also be practised from each side of the machine. These vaulting mounts are rather a severe strain on a machine, and should not be attempted on very light ones.

Dismounting may be done by reversing most of the above mounts. In getting off by the pedal the weight should be leant on the descending pedal on the same side of the machine as the rider wishes to reach the ground, then the other leg may be slung round the back of the wheel or in front of the saddle, or he may simply step back, but in this case great care should be taken to reach far enough back or a serious accident may result.

Riding side saddle: Either mount as usual, but keep both legs on one side of the machine, or bring the leg over the frame round the front of the saddle. Keep up a good ankle stroke with the outside foot. As the machine leans away from the rider, turning towards that side should be made carefully, or the machine will slip down with its rider on top of it. This mode of riding is not much use, but it gives a change of position which may be taken advantage of on long gradual declines on a tiring journey.

Riding without holding the handles is not so easy on the average rear-driving safety as on the old high bicycle; the feet have so much less control over the steering. At first it was thought that only those machines which had straight front forks could be ridden "without hands," but further experience has fully demonstrated that forks so curved as to bring the steering line three or four inches behind the centre of the wheel can be so steered, though perhaps not quite so easily. We think it is more important that the line through the steering should not lean either to the right or left, than that it should be at a particular angle with the ground fore and aft. To ride in this way, it is necessary to first become proficient at steering with only one hand at a time. Then get up a fair speed—not much less than ten miles an hour—sit well back, and pedal very evenly. The head of the machine should work easily and preferably on balls; a ball socket head brings the steering line further forward towards the centre of the wheel, that is, nearer to a castor action, and is therefore advantageous in this connection.

It is useful to be able to let go of both the handles at once, not only as a change and rest, but there are often times when two hands are better than one, and a dismount would be a nuisance. It helps, too, considerably in making the cyclist a complete master of his steed.

Keeping stationary on the machine: For this the chain should not be too loose—the tighter the better, in moderation—the rest depends on the rider. Ride along gently, and when the machine has almost stopped and the right foot is about half-way on the down stroke turn the front wheel 45° or more to the right and remain in this position. When inclined to fall to the right, tread more on the right pedal, and when to the left on the left pedal. The steering has not much to do with keeping the balance in this position, and after a time the right handle may be rested against the body and the hands removed from the handles. The reason for turning the steering wheel across is this. The machine cannot fall backward or forward owing to there being two supporting points in this line, and if the machine be propelled forward a little the supporting line is moved to the right, and if the back pedal be pressed the line is moved to the left. If the front wheel were kept straight pressure on the pedals would only move the line lengthways and not from side to side. This feat is sometimes very useful, and should also be practised with the left foot forward, the steering wheel then being turned to the left.

Riding with the front wheel in the air is a comparatively common performance in America, and many other tricks more or less useful to the rider will occur to him as he proceeds.

CHAPTER V.

RACING.

CYCLE racing is becoming more and more scientific, and as our practical experience has not extended to much more than one season in this direction, we shall not give more than a few hints. It is a subject large enough to fill a book by itself. Indeed, several have been devoted to it, and they should be consulted for further particulars.

There is more good to be got out of racing than most people imagine—apart from prizes altogether. It gives the rider more manliness, pluck, and determination, and more perfect control over his muscles. At first, the novice will not be able to run himself out, try as he may, but it will come with practice. Again, the rider's health will be greatly improved by the early hours and wholesome living. It will give him a spurt and staying power which will afford him much satisfaction when riding with others on the road. And racing among other cyclists is more interesting to one who competes occasionally himself. These prizes, at any rate, may be won on the path, whomsoever the cups and clocks may go to.

The tyro won't meet with much success on the path, even in handicap races, unless he can cover a mile in, say, 2m. 40s. When he can do this, he may take the next step, and one which it is suicidal to omit—to consult a doctor, not a bigoted eighteenth century sawbones, but one who is, at least, not prejudiced against cycling. Tell him what it is proposed to do, and if, after due examination, the aspirant is passed as sound, he should promptly cut off alcoholic drinks, chuck up smoking (let us hope permanently), and proceed to get into as healthy a condition as possible. Pastry, rich and fat meats, and other indigestible food, should give place to porridge, lean beef, mutton, well-cooked vegetables, and other plain muscle and bone-producing fare. Early hours (in bed by ten or half-past, and up about seven) should be kept, and plenty of sleep enjoyed. A cold bath should be taken on rising (if it produces a glow), and a breath of fresh air inhaled before breakfast. After breakfast half an hour or an hour's gentle exercise (*e.g.*, ride or walk to business, or part of the way if too far). Avoid hot rooms and underground railways. Visit the track for about half-an-hour in the evening, and be careful to avoid chills. Supper should not be a

heavy meal, nor partaken of late. An oatmeal biscuit, or something else light and sustaining, should be eaten just before going to bed. It may be more convenient to practise at some other time of the day, but it should not be too soon after taking a meal, and it is better to have one or two other riders on the track at the same time; it makes the practice more interesting.

The old way of practising consisted in going as far as one could at full speed until one could go the whole distance of the proposed race at full pressure. This seems very good in theory, and might answer well for short distances, but it would take rather a long time to prepare in this way for a race of fifty miles for instance.

The final burst is the great thing practised nowadays, though general pace also receives attention. The result being, that in a scratch race, none of the best men will lead or make the pace, and if one rider tries to go so fast as to tire out the sprinters, they will keep up behind him, and then beat him in the final tussle. It is much harder work leading at twenty miles an hour than to follow behind someone else who is doing so. The limit man (*i.e.*, the one who receives most start) in a handicap is at a disadvantage in having to make the pace. This refusing to make the pace leads in unpaced races to funereal crawls round the track until the last lap (or circuit), which is ridden at about thirty miles an hour. The short races, even for championships, are really races for about 400 or 500 yards only.

But to return. Take care not to lose your head either in practising or actual racing. The faster man is often out-generalled by the slower. When riding neck and neck with another man, and you feel as if you could not keep up the pace another moment, remember that your opponent probably feels quite as bad, so, if possible, try and get even a temporary advantage of him, and he will very likely "throw up the sponge."

Don't time yourself too often, in fact, don't do it at all until you have been practising a week or so, as by that time you will probably be going slower than you were at first, and to realise that in seconds would discourage you. It is also discouraging to be run away from by anyone who is kind enough to make the pace for you in practice, so do not ask too good a man to do it. Don't be slow to make pace for others if asked to do so; it is good mental practice, and you may find yourself leading in a race sometimes.

If in a scratch race the leading man is going at a faster pace than you think you can keep up for the distance spurt to the front, and gradually slow down a little; you may get temporary relief in this way. On the other hand, if you feel certain you can do the distance faster than the other man, take the lead and go as hard as ever you can; if your scheme has not succeeded by the time it is getting near the end of the race, slow down,

letting someone else take the lead, if possible, so that you may have time to prepare for the final rush. Riding all out in this way becomes almost necessary if pacemakers are provided.

Have the relative positions of the saddle and pedals the same on the racer as the roadster, but the handles may be set lower. Some of the makers of the best roadsters are not so successful with their racing machines—ease of running is the great thing. This cannot be obtained without sufficient strength, but, on the other hand, weight must be cut down as far as possible. In seeking advice from other riders be wary of those who are likely to be interested in advising you. The purchaser's weight should be distinctly stated when ordering, so that the machine may be built accordingly. Within reasonable limits all that can should be done to give the rider confidence in and comfort on his machine, but he should leave the weight to the maker, as if the machine be too light it will not run so easily as it would if it had had enough metal in it to be rigid against such strains as have a tendency to bind the bearings.

The following hints are taken partly from the writings of Mr. G. Lacy Hillier, the acknowledged expert on cycle racing.

Always look where you are going. If you get into the habit of guiding yourself by the edge of the track you are very apt to run down a competitor in front of you—simply because you did not see him.

Always sit straight. One is apt, especially on a small track, to get into the habit of sitting on one side of the machine, which tends to spoil the action of the outside leg.

Pedal evenly and use both legs. A sore foot may get the rider into the way of using one leg more than the other, and he will very likely omit to shake off the habit after the cause has gone.

Pedal straight without bending the knees out or in.

Keep the feet straight, and do not let them move sideways on the pedal.

Don't wobble the shoulders, keep them still without too rigidly setting the muscles of the trunk.

Hold the body still and sit down. Many riders rise off the saddle when spurting, thus unsteadying the steering and diminishing the power at the worst time. A slight grip of the peak of the saddle is useful when steering round awkward corners.

Don't shake the head, it interferes with watching your opponents and judging your course. If you lean forward carry your head up. If you want to listen for your opponents who may be coming up behind, turn your head slightly away from the track, and stop the forward ear with cotton wool, as the wind blowing in may set up a cold and cause deafness.

After practice, the rider should have his legs rubbed by hand—

especially the shins and calves—the while he relaxes his muscles. The rubbing should be upward only, this being the direction taken by the blood in carrying off the waste tissue.

Great care should be taken with any points in which the rider is weak (*e.g.*, staying or spurting), and they should be hammered at until he is really good at them. Difficulty in negotiating corners may be at any rate partly removed by practising on a track with bad corners.

Unlike most other exercises—particularly running—walking works in very well with cycling; in fact, some of our best long-distance riders consider it an important part of their training.

When on the path, as elsewhere, be a gentleman and a sportsman (by which we *don't* mean a betting man). If you win, don't boast; if you lose, don't excuse yourself.

Don't give up the whole season to racing. Wait until your road riding has put you in good trim, and given you some sound muscle to work upon.

Take care that all open races you enter for are advertised as being held under N.C.U. rules, or you may find yourself a professional, debarred from competing with amateurs in future.

TRAINING.

The Hospital recommends the following way of taking a cold bath. Stand in a few inches of warm water. Sponge head, limbs, &c., with cold water, applying it last to the nape of the neck. Both applying and drying should be done quickly, the exertion being good. It says this is just as good as an ordinary bath, and there is less danger of apoplexy. At any rate, with a small sheet of macintosh, a jug of warm water and another of cold, and a sponge or loofah, a good bath can be obtained almost anywhere.

Proper training should never upset anyone, but should get him into the best of health and spirits, and keep him so. To train specially for racing is a rather different and, perhaps, less beneficial undertaking. The one great rule is to do what you know suits your constitution, and to cut the opposite. Diet is essentially a personal question, but we believe tea, coffee, and pie-crust are bad for almost everyone, and that potatoes are not desirable in summer. Most people eat too much meat, and do not give it a fair chance by proper mastication. On the other hand, vegetarianism does not agree with everyone, and it should on no account be adopted suddenly.

We are decidedly against fasting for ten or twelve hours during the night, and recommend a light meal before retiring and a cup of cocoa before or immediately after rising. Anyone who has sat up frequently during a whole or the greater part of a night will remember how hungry he became in the small hours. Those who

are not in the habit of taking a meal shortly before retiring will notice that if they do take such a meal they will get up much more hungry than usual. If the cravings of hunger are not satisfied when felt, they will pass off, after an hour or two, for a time, but the neglect, if constantly practised, will have a very injurious effect. We are strongly inclined to believe that this is what happens, though in a slighter degree, to those who have a meal about seven or eight in the evening and nothing more until about the same time, or even later, in the morning. As to its being bad to go to bed soon after a meal, is it not natural to sleep after eating?

It is not good to take active exercise directly after a meal, as the blood is wanted for digesting purposes, and should not be drawn away to the muscles. Still we do not remember having suffered from indigestion through cycling soon after eating. On the other hand, it is as well to begin by riding slowly.

After all that has been said for and against tobacco and alcohol we do not think many seriously consider them advantageous to health.

Those who get little opportunity for exercise should take care how they spend their whole or even half-holidays—used in moderation they are exceedingly valuable, but incalculable harm may result from over-doing it—actual strength of will in resisting the temptation to go beyond one's real powers is far better than the improperly assumed strength of body which the rider might arrogantly desire to get credit for.

Large quantities of liquid gulped down are not conducive to the best condition. Though thirst should be quenched it should be treated with small quantities of lemon-squash or a similar quencher; plain water is not altogether satisfactory.

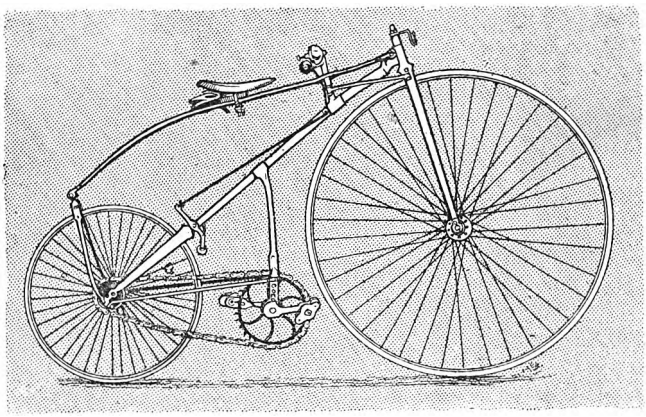
Sleep on a mattress in a cool bedroom (55° to 60° Fahr.) Do not let the clothes be either too heavy or too hot.

Exercise ceases to be beneficial when it becomes wearisome.

Excessive perspiration indicates want of condition to treated by a cold bath and perhaps a tonic.

Reckless riding brings its own reward immediately, or, though little less certainly, in after years.

Neither training nor any athletic exercise should be given up suddenly. The organs become adapted to do a large amount of work, and if they do not have this work to do may become diseased from disuse. The mind retains its powers longer than the muscles, so that a man who has trained but has got out of condition should take care not to race hard without due preparation.



H. J LAWSON'S BICYCLETTE, 1879.

CHAPTER VI.

CHOICE OF MACHINE.

IN choosing a safety bicycle or any other cycle, one has to consider the purpose of its use. It has to suit both the rider, and the roads it will be used upon.

As to the rider, it must be sufficiently strong to carry his weight and rigid enough to withstand the power he will put forth in driving. It must be more or less free from vibration according to his ideas of comfort.

There are many riders who have no idea of the way in which their machines work; all they can do is ride them, and perhaps oil them, but if any part requires adjustment or other attention they are totally unable to do what is necessary. A number, no doubt, have some idea of the mechanism of their machines, and the advantages are obvious; it assists them both in choosing and in keeping their cycles in order, thus adding to pleasure and reducing expense. Let us then consider the construction of the rear-driver so that we may understand its whys and wherefores, and be able to see what is good and what is bad in any particular machine.

Roughly, the machine consists of two wheels in line connected by a framework, which also carries a saddle and a portion of the gearing. The back wheel is driven through the gearing, and the front wheel is mounted on a pivot, so that it may be deflected from a straight line for steering purposes. First let us take

THE WHEELS.

Each wheel consists of a centre or hub, connected to a circumference or rim by spokes; to the rim is secured a more or less elastic tyre for reducing the vibration set up by the unevenness of the road surface, which would otherwise be a source of bodily discomfort to the rider, besides wasting his power, and so reducing his speed.

The front wheel has varied in size from 18in. to 36in., and the back wheel from about 24in. to 36in., but they have settled down to 28in. or 30in. for the front wheel, and 28in. for the back, though they are sometimes made somewhat less for racers. By decreasing the size of the wheel, rigidity is increased, and weight reduced, but vibration is more felt, while by increasing the size, the opposite

results are obtained. Rigidity is more necessary in the back wheel, being the driver, than the front. Vibration is more felt in the front wheel than in the back, as there is no spring to the handles, as there is, usually, to the saddle.

The hub consists of a centre or tube, and two flanges fixed or formed at some distance apart on the centre. If the centre form the axle of the wheel, it is usually solid, but if the axle or spindle do not revolve, being fixed to the frame, the centre is hollow. The bearing parts of the hub ought to be of hardened steel, the centre should be steel, and the flanges may be. Gunmetal flanges are easier to drill and tap, but the threads are also more easily stripped. For direct spokes the flanges are left thicker than when the spokes are merely laced or headed into them.

Steel flanges are almost always used for laced and tangent spokes. The reason for placing the flanges at a distance from one another is to make the wheel strong sideways. If all the spokes were fastened to one central flange, the wheel would "buckle" or collapse directly the machine and its rider deflected appreciably from the vertical plane. We shall refer to the hubs again under the head of Bearings.

The rims form the frames of the wheels; they are supported, or rather tied in, all round by the spokes, and hold the tyres. They are sometimes hollow and sometimes solid. Hollow rims are not always worth the extra expense charged for them on such smal wheels as those used in the rear-driving safety, as they often actually weigh more than solid ones, and the increased rigidity is not required. To reduce the weight of hollow rims exceedingly thin steel is used, which is necessarily more liable to damage than the thicker material used in solid rims. Some of the large and intricate rims used for pneumatic tyres are, however, almost necessarily hollow.

The spokes may be fitted radially (or direct) or not radially when they are called laced and tangent spokes.

A pure suspension wheel, such as the front wheel of the rear-driving safety bicycle, which is rotated by the friction of the road against the tyre, should be fitted with direct spokes, as they will be in the line of strain. A wheel which is rotated by power applied near the centre, and through the spokes to the rim, should, so far as the driving is concerned, have the spokes fitted tangentially from a central flange to the rim; such a wheel would be no use for carrying weights until supported by spokes running to two flanges placed some distance apart. As a greater proportion of the weight comes on the rear wheel than on the front, the former has to be built with more spokes than the latter, quite independently of the driving strain. For roadster wheels, thirty-two spokes to the front wheel, and a dozen more to the back, should be fitted. This compara-

tively large number of spokes of course makes the rear wheel proportionately more rigid as a driving wheel, and in most driving wheels, properly built on the direct system, there is probably not much loss of power between the hub and the rim.

In some machines just a few spokes are fitted tangentially in addition to the direct spokes, but this may put an unfair strain on the rim at the points where they are fixed.

Tangent spokes, instead of forming radii in the circle of the wheel, leave the flanges nearly at a tangent. They are usually headed at the flange and screwed into small nipples in the rim, but occasionally they are headed at the rim and screwed into the flanges.

All spokes that are not absolutely radial are necessarily tangential to a circle of some diameter, however small. Ordinary tangent spokes are not tangential to the edges of the flanges, but to a circle passing through the spoke holes in the flanges. The term true tangent is sometimes applied to spokes arranged in parallel pairs radially.

True tangent spokes in a small wheel imply either an unnecessarily large number of spokes or very large flanges. Sixty spokes and flanges 4in. to 5in. in diameter may be all very well for the large wheel of an ordinary bicycle, but they offer too much resistance to the wind, and are too heavy for the small wheels of a rear-driving safety bicycle.

Laced spokes derive their name from being laced through the flanges and in and out of each other on their way from the flanges to the rim; they are not usually set at a true tangent to the flanges, and a smaller number is used. They and tangent spokes are usually more expensive than direct, and we do not think they are worth much extra money unless lightness is a great consideration. They have the incidental advantage of leaving the lubricators in the wheel centres more readily accessible than where the spokes are radial or direct. Tangent or laced spokes are mostly used with hollow rims, as these accommodate the heads of the nipples better than solid rims.

The size of the spokes depends to some extent on their quality. A really good steel wire 14g., butted 10g. or 11g., will stand a strain of 600lbs. to 900lbs. without breaking, which is ample for a roadster.

A direct spoke has a head formed on one end and a screw thread on the other. It is passed through a "countersunk" hole in the rim, and screwed into a "tapped," *i.e.*, screwed, hole in the flange. The threaded part of the spoke should be screwed right down into the flange, and if it be "buried" one-sixteenth of an inch it will partly remove the strain from the part weakened by cutting the thread. All the spokes, of whatever kind, in the wheel should be equally tight.

When direct spokes are used in a driving wheel, the strain of driving comes on the spoke, primarily sideways and secondarily lengthwise, the looser the spoke the more the side or shearing strain is felt, and the tighter the spoke the more immediate is the pull lengthwise. This shearing strain is greatest where the spoke enters the flange, hence the importance of having it "butted" or thickened here, more especially as the screw thread being cut into the butt, the effective size of that part of the spoke is reduced. These two reasons will show why a direct spoke which is not butted is so liable to snap at, or just inside, the edge of the flange. Laced spokes which are bent at the flange should also be butted there, and if they are also butted at the threaded end so much the better.

THE TYRES.

As before stated, the object of the tyres is to reduce vibration. With a rigid iron tyre, as in the old boneshaker, and nearly every modern vehicle except the cycle, the machine and rider have to be raised over every obstacle that will not crush down under the weight. This raising is accompained by a corresponding falling, and together they produce a more or less pronounced jolt, which is uncomfortable and so wearing to the rider, and which is liable to disturb his pedalling. Again, the raising of the weight cannot be performed without the expenditure of force, and as this force is, under ordinary circumstances, supplied by the rider, though possibly to some extent indirectly, and as the upward movement is not only not in the direction in which it is desired to propel the machine, but is also out of its path of momentum, it will be seen that the raising of the machine and rider over the obstacle is effected at a loss of power, which is by no means compensated by the subsequent falling as the obstacle is passed.

It will also be seen that vibration and loss of speed are very closely and inseparably related. The tyre, therefore, should be capable, within reasonable limits, of indenting to such an extent as to give way to, or swallow, all ordinary obstacles, and thus allow the machine to pass over them without being raised. At the same time this capability must not be counterbalanced by disadvantages, such as undue weight or unsteadiness. Another evil has to be guarded against in the driving wheel tyre. The propelling power is applied to the hub, and is communicated thence by the spokes to the rim, and from the rim to the tyre, which engages directly with the road surface. The part of the tyre on the ground is more or less flattened by the weight; it is pulled backwards by the rim, and is prevented from going in that direction by the road friction; hence there is always a tendency for the tyre to bunch up into a more or less pronounced lump in front of the point of contact

between the tyre and ground, which lump is constantly being compressed as the machine travels forward. The more ductile the tyre, the worse the lump, and the more "drag" or loss of power will be felt. The more rigid the tyre lengthwise, especially tangentially, from the rim to the "tread" or surface of the tyre in contact with the road, the less the lump and drag, and the quicker the tyre is in re-acting the more will the compression in front of the point of contact be compensated by expansion behind it. The front wheel tyre is rotated by the road, and so is subject to different conditions; the driving wheel tyre, unless firmly secured, tends to "creep" or slip round the wheel backwards; the front tyre tends to creep forwards, though with less persistency. There are already signs that running wheel tyres and driving wheel tyres, instead of being built exactly alike, will eventually be constructed with a view to their different conditions and work.

The supersedure of the iron tyre by one of solid indiarubber was a great advance, as the new tyre absorbed the vibration to a very noticeable extent, until the craving for lightness reduced it to an often absurdly small size. The introduction of the pneumatic and cushion tyres opened the eyes of the cycling world to the fact that increased weight might be accompanied by increased speed—a fact which had too often before been regarded rather as a theorist's fad.

The Cushion tyre is merely a large rubber tyre with a hole through the centre. The hole slightly reduces weight, and allows the rubber to act more freely. At first the holes were made too large, and the tyres cracked and parted level with the edges of the rim, and when it is remembered that each part is compressed and released, say, about 700 times in one mile, the result was not surprising. It is found that the cushion tyre, though heavier both in itself and in the rim holding it, is decidedly faster and more comfortable than the old solid tyre. Its increased width, however, naturally distributes the pressure of the weight over a larger surface, and it provides a less secure hold on the road, especially sideways, so that when the road is lubricated with greasy mud, or even with thick dust, the rider's balance is liable to be upset by the wheels slipping sideways from under him.

The pneumatic tyre in its simplest form may be described as a cushion tyre having the hole filled with air above the normal atmospheric pressure. In its developed state the pneumatic tyre consists of a ring of compressed air enclosed in a light covering. The great gain of the pneumatic tyre consists in the substitution of the highly and quickly elastic material air for the *comparatively* inelastic and sluggish material indiarubber. The rebound of compressed air itself is instantaneous, and to retard this action as little as possible the covering must be extremely

flexible. Any attempt to hasten the rebound or elasticity of the air by the introduction of elastic materials, such as spring steel, into the cover must necessarily be worse than useless, as the air will be capable of acting quicker than they, and hence will be hindered by them. Similarly, if the cover be made capable of expansion, *i.e.*, enlargement of cubical contents, on the application of increased pressure from within or without, and of contracting again on removal of such increased pressure, the elasticity of the air will be impaired, being adulterated, so to speak, by the less elastic expanding and contracting material; the air will have a less rigid base to work on—just as a glass marble dropped on to indiarubber will not rebound so high as if dropped on to a stone or metal plate.

The extreme elasticity of the air, the flexibility of the cover, and the large diameter of the pneumatic tyre make it highly efficient in annihilating vibration by swallowing obstacles. Further, the power absorbed in compressing the air in the driving wheel tyre at, and in front of, the point of contact with the ground, also acts to compress the air throughout the whole tyre, and as fast as the air is compressed in front of the point it expands behind it in such a way as to assist in propelling the machine forward, so that there is very little loss or drag from this cause unless the air be insufficiently compressed.

The cover of the tyre consisted at first, and sometimes does still, of canvas, but this does not give the best results, for though it is highly flexible, the threads being interwoven, cannot move with respect to each other, and consequently when an obstacle is swallowed, a long piece of the cover is affected, and the likelihood of raising the wheel is increased. In a mere running wheel, the longitudinal threads might be drawn out, and the transverse threads left, being kept in place by solutioning or cementing to a thin strip of rubber; this would allow of swallowing with none but the most local disturbance. But in a driving wheel tyre the longitudinal extensibility would involve a waste of power, if not destruction of the cover. The best compromise appears to be to retain both warp and weft threads, to arrange them diagonally across the tyre, and *not* to interweave them. The two layers of thread may be attached to either side of a thin strip of rubber; the threads can then move independently and without sawing each other, and there is sufficient longitudinal firmness to preven drag. On the other hand, it may be worth while, where economy of power or highest speed is desired, rather than great immunity from "small" vibration, as for racing or riding on hilly roads generally free from swallowable obstacles, to introduce a longitudinally rigid band into the tread of the driving wheel tyre, and even to connect it tangentially to the rim. The exterior of the

cover is usually protected by a casing of indiarubber; this substance being waterproof and highly flexible, it also gives a good grip and wears well, but being slowly elastic the strip should not be too thick. The rubber and fabric of the cover should not be vulcanised together, as this tends to decrease both flexibility and strength.

Pneumatic tyres, though still heavier than the old solids, are usually lighter than cushions, and they are about as much faster than cushions as cushions are than solids, say five or six per cent. Pneumatic tyres show at their best on surfaces which are very irregular within comparatively small limits, such as granite setts; on worn macadamised or other lumpy roads they bounce a good deal, and a good saddle spring is required to minimise the movement. On a smooth surface the increase in speed is naturally more noticeable than the increase in comfort.

But the large size of the pneumatic tyre makes it more liable to side-slip than even the smaller cushion. Numerous inventions have been brought out to eradicate the evil, but we do not suppose that anything will ever be absolutely successful. The usual plan is to provide the cover of the tyre with more or less pronounced projections, but if the mud be deeper than the length of the projections it is obvious that they cannot obtain a hold on the firm ground below. Unless the projections are individually or collectively continuous they cause vibration on ordinarily hard surfaces, and prevent the use of a brake acting on the tyre. They may interfere with the flexibility of the cover and add to its weight. If suitable for muddy roads, they may be unsuitable for wet hard surfaces such as asphalt. We must not be thought to object to "non-slippers"; on the contrary, we think that every roadster bicycle should be provided with them; we are merely indicating the difficulties with a view to helping to make a selection. A single ridge along the centre of the tyre, large enough to support the weight and itself forms the tread, with fairly sharp edges, and a rough surface, would be about best if it could be obtained without unduly interfering with the flexibility of the cover, and without unduly increasing the weight.

Side-slipping is not a pleasant sensation. The first lurch is both surprising and alarming, especially if it deposits the rider on the greasy ground. But a side-slip need not necessarily result in a fall; it is almost always the rear wheel that slips, and so long as the front keeps steady one can generally manage to hang on, bu if the front wheel goes it is "all over." In riding over slippery ground pedal evenly, hold the handles firmly yet freely, lean a good proportion of weight on the front wheel, and steer a straight course. If the road slopes much to the gutter, ride in the centre, if possible; if not, pedal most with the foot nearer the gutter. If there is much traffic about, or the mental strain becomes severe, it is best to dismount.

One of the simplest non-slippers consists of a strip of saddler's webbing, like boot loop material, only about 1in. or 1¼in. wide. A strip to fit round the wheel, and two or three inches to lap over, should be cut off, dried, and thoroughly impregnated with solution (rubber dissolved in benzine or naphtha), two or three coats being laid on and allowed to dry in succession. The tread of the tyre should be thoroughly clean and dry, and it may be roughed a little with glass paper; it also should be solutioned with two or three coats. The tyre should not be fully inflated. The ends of the band should be stitched together (after passing one through the forks), to make a circle that will tightly fit the tyre when inflated. When the last coat of solution is nearly dry the band should be put on with the outer end towards the back when the join is at the top of the wheel, so that this end comes to the ground last, and is not liable to be dragged up by the brake or the ground friction. Arrange the band carefully along the centre of the tread, blow the tyre up hard, and press the edges of the band close down. When the solution is quite dried the machine may be used. Rubber bands with greater or less corrugations and other contrivances are sold, which may be fitted on by the rider. A piece of thick cord wound round the tyre is better than nothing, but the ends should be firmly secured, and it must not be so thick as to catch in the mudguard stays, or other parts; about as many turns as there are spokes will do.

Nobody needs telling what is the besetting sin of pneumatic tyres. They are liable to be punctured and the air to escape, and this little peculiarity has a good deal to do with their construction. A pneumatic tyre is a comparatively expensive article, and if it were to be rendered useless the first time it was punctured, it would not suit the average rider at all. Facility of repair is, therefore, an important point to be considered.

To more effectually contain the air, the cover of the tyre is lined with indiarubber. Sometimes the lining is part and parcel of the cover, but more often it is separate from it, and is then known as an air-tube. Tyres constructed on the former plan are known as "single tube"; the others are called "double tube" or "built-up." A puncture in a single tube tyre is repaired by filling up the hole with solution or with a plug of indiarubber. A double tube tyre is repaired by sticking a patch of rubber on the damaged part of the air-tube, and to do this it is necessary to undo the tyre by opening the cover. Directions for making these repairs will be found on a subsequent page.

We doubt if any gain in speed or comfort is to be derived from the use of a separate air-tube, and though such a tube is more certainly reparable than a single tube tyre, we think it probable that tyres will eventually be constructed on the single tube principle,

but in such a way that they may be opened and patched on the inside. Meanwhile, the question of how the cover of a built-up tyre is made to open and close is of considerable importance. Methods well-nigh innumerable have been devised, but the surviving fittest are settling down into two classes: First, those in which the cover is bound to the rim by a wire passing along each edge. In some cases these wires are endless, and the cover is opened by pressing the wire down round one part of the wheel, into a central groove, which leaves it free enough at the opposite part to come easily over the edge of the rim, or perhaps we should say "ought to leave it," for though the idea is charmingly simple and ingenious, in practice the measurements are run so fine that if the fit of the wires and rim be not perfect difficulty is found in opening and closing such tyres. In other cases the ends of the wire are not rigidly united, but are held in such a way as to allow of the edges of the cover being enlarged to get it out of the rim. Such contrivances should be provided with a screw, to enable them to be adjusted if required, and steps should be taken to prevent the screwed parts getting wet and rusting together.

The other class of construction consists in making the edges of the cover of hook-like section, or of attaching hooks to the edges, and in making the edges of the rim of corresponding form, so that the cover may be hooked to the rim. In this method the security of the cover depends more or less (in some cases very much less) on the inflation of the tyre, which is a bad principle, as if the tyre were to leave the rim it would be very likely to get mixed up with the frame and cause a serious accident. And this might happen quite easily to a machine fitted with the usual plunger brake on the front wheel, for if the front tyre punctured and deflated, the brake would be useless, and the cover might leave the rim before the machine could be pulled up. Wired-on tyres are not, as a rule, so liable to this defect.

In selecting a tyre, one has not much choice as to the valve it shall be fitted with. The easiest valves to use are those which require no further manipulation than removing the dust-cap and screwing the inflator or pump on; these may be described as self-acting. The passage through the valve should be sufficiently large to admit the air with a fair amount of freedom. The little chain holding the valve in the driving wheel should be secured to a spoke that does not run to the chain side of the hub, so that if the cup work loose it will not be so liable to get caught in the chain.

The inflator supplied gratis with the machine is not usually a very powerful affair. It should be remembered that the power does not depend on the length of the instrument, but upon its diameter; the smaller the transverse area of the piston, the greater the power.

THE FRAME.

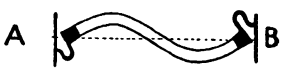
A few years ago the subject of the frame would have occupied very much more space than it need do now. This part of the machine had been through some wonderful changes before the present degree of perfection was arrived at. Still it will not be out of place to consider the points of a frame, though so long as the purchaser selects one of the present well-nigh universal straight tubed diamond frames he will not be likely to go far wrong.

The frame as a whole must be sufficiently strong and rigid, lengthwise to unite the two wheels, vertically to carry the weight, and horizontally and otherwise to withstand the driving strain. Considered in the direction of its length, every safety frame has a weak point in its design, namely, just over the front wheel, at the bottom of the head. The more the head and fork depart from a vertical position over the centre of the front wheel the greater the strain. If the machine were to break at the head when standing still with the rider in the saddle the front wheel would go forward and the rear wheel backward. But when the machine is travelling along, the friction against the road resists the front wheel's going forward, *i.e.*, tends to force it back, at the same time the rider's power exerted in driving makes the driving wheel run forward. There are thus two strains on the head, the greater (caused by the weight of the rider) being to some extent counteracted by the less, that set up by the driving of the back wheel and road resistance to the front wheel, so that theoretically the harder the machine is driven the less strain there is on the neck, and this theory is justified by the fact that breakages about the fork crown more frequently occur at slow speeds than at high.

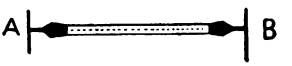
To be perfect in design the frame should consist of a single girder, having one of the wheels fixed firmly at each end; but this is impracticable, as the front wheel must be deflected for balancing and steering purposes. Therefore, the front end of the girder is carried up over the front wheel, and a single unsupported fork, capable of turning with respect to the girder, runs down from it to carry the wheel. Vertically, the girder should be deep, the greatest depth being under the saddle, and the least at the extremities; the figure should be properly stayed, and the metal should be continuous along the outline of the figure, so that it shall not collapse, sag, expand, or contract. Where two points in a frame have a tendency to move towards or apart from each other, they should be connected by a strut or tie (preferably a tube), and as strains always follow the shortest course, the tube must be straight, and must follow that course if the best result is to be obtained. Nor is it enough that the tube itself follow the line; the joints or

connecting pieces at the ends must follow the line too. If A and B are two points, say on two bars, that are subject to a strain

tending to draw them together, the strain will act along the dotted line, and even though the tube be in line, if the joints are cranked as shown, the result indicated in the next figure will be liable to ensue.



The way they ought to be arranged is thus :



The strain would then have to be sufficient to compress the lugs or buckle the tube before anything would happen. It took a long time for this fact to be appreciated ; within the last two or three years we inspected a new design by one of the oldest and largest firms in the trade, in which the supporting parts were, as nearly as might be, twice as long as the distance between the parts, and contained at least five violent turns, and the special object would have been fully achieved if the support had been straight and short.

Another unappreciated fact was the valuable rigidity of triangles. An immense number of machines were for a time made with frames similar to the present, but without any direct connection between the saddle and the bottom bracket, and at least one of the prominent present day firms yielded reluctantly to public opinion in rectifying the omission. Now, the saddle-pillar lug, the bottom bracket, and the rear wheel axle, three of the most important points in the machine, are located at what for the moment may be considered as a straight-tubed triangle, with very satisfactory results. It might be thought that it would be a good plan to "triangulate" the part in front of this triangle by bringing the two backbones together in front, the "diagonal" tube forming a side of both figures, but this would exaggerate the weakness of the point over the front wheel before referred to. But it might be maintained that if it cannot be made into a single triangle, still it might be made into two by a tube running from the bottom

bracket or the saddle-pillar lug to the angle respectively diagonally opposite to it, thus tying the angles and taking the strain off the joints, and at the same time leaving the front ends of the backbones at any desired length apart. No doubt it would make this part of the frame more rigid, but we very much question if it be worth doing—for it has been done in several instances. But, in experimenting with a model one day, we discovered that, under normal conditions, there is very little strain on the four angles at the ends of the two backbones. Consider these joints as hinges with horizontal spindles. It will be noticed that the upper backbone is nearly horizontal, but the lower one drops a good deal from the head to the bottom bracket. If a weight be put on the saddle the back triangle will tend to drop forward and downward in a curve, turning on the rear wheel axle as a centre. As the top of the triangle goes down it also goes forward, and so, through the upper backbone, pushes the top of the head forward and upward. At the same time the bottom bracket goes down and slightly back, and pulls the bottom of the head back. These two actions on the head bring the head, and therefore the forks, into a more vertical position, and consequently raise the head; raising the head necessarily raises the bottom bracket, and raising this part raises the whole back triangle. From this it is obvious that there is a position at which the falling of the triangle and the raising of the head balance each other. This position is not far from the normal position of the frame in a modern rear-driver, and the strain on the angles of the front part of the frame is small, and breakages are few. Horizontally, the frame should be widest in the centre and narrowest at the ends to withstand lateral strains, especially the alternate lateral pressures arising from pedalling, and though this arrangement does not at present appear to be possible, we think the necessity for great lateral rigidity has been somewhat overlooked.

Having dealt with the frame as a whole, we will now consider more in detail the two parts of which it is composed. First, the front frame, consisting of the front fork, head tube, and handle-bar. Second, the rear frame, consisting of the head socket tube, the upper and lower backbones, the diagonal, the back stays, and the back fork (the last two may also be called the lower back fork and the upper back fork respectivelv), and the saddle-pillar.

THE FRONT FRAME

connects the front wheel to the rear frame, and connects the handles with the wheel, so that it may be turned for steering.

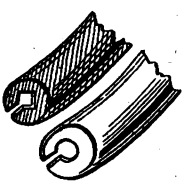
The Front Fork is composed of two prongs or fork-sides, fixed to a crown. Each prong consists of a steel tube, usually oval in section, with the longer axis set fore and aft. The ovalling is to

increase the resistance of the machine against elongating under the weight, but this is not everything. The necessity of making machines rigid sideways, to withstand the alternate pedalling, is much too little regarded, and the front fork is capable of considerable improvement in this connection. What is required is to make it much more nearly circular in section than is usually done.

In the old days, when solid tyres, narrow crowns, and wide hubs were used, the fork sides spread apart as they ran downwards, and the figure formed by the fork, axle, and crown was not far from that emblem of rigidity, a triangle; but now the fork sides run parallel, and the figure is changed to a rectangle, and is correspondingly weaker, hence the necessity of increasing the length of the shorter axis of the oval tubes. We wonder that more makers do not try round fork sides; they would be cheaper, more rigid laterally, and would carry less vibration to the hands. Of course, they would require lining for some distance down from the crown. Those who have tried them speak well of them.

A straight fork brings the point of contact of the front wheel, where the vibration is set up, more directly in communication with the handles than a fork curved forward as it goes down, and so the latter is more comfortable. The principle of castor steering is more nearly approached with a straight fork than with a curved one. A slightly curved fork bringing the steering line to meet the ground about three inches in front of the point of contact is found to give a happy combination of comfort in the handles and ease of steering.

The holes in the fork through which the front spindle passes should be large enough to fit on to small shoulders on the outsides



of the cones instead of directly on to the spindle, and the holes should be cut through to the edge, the passage thus formed being large enough to let the pin through, but not the shoulder on the cone—something like a button-hole. By slipping the fork outwards off the cones the wheel can be easily detached as the pin passes through the passages. If these passages be not cut the prongs or fork sides have to be pulled outwards sideways over the ends of the pin, which is a mutilating operation to the fingers and temper, and by no means good for the fork.

The Head Tube rises from the crown, to which it should be firmly brazed over a good length, and it should be further strengthened

by a strong tubular plug three inches or more long fitted tightly into the lower end. The head tube forms the centre or spindle of the socket steering, and the stem of the handle-bar is telescoped into its upper end. Though this tube is out of sight, the safety of the rider depends on its strength to a very great extent.

The Handle-bar consists of the bar itself and the stalk or stem by which it is connected to the head tube. The stem should be about eight inches long, and must fit the interior diameter of the head tube into which it fits and is fixed, and should be of a good stiff gauge. The tube forming the bar must be strong and stiff, as, not being supported directly at the ends, the leverage on the joint at the centre is very great; $\frac{7}{8}$in. is a very good size, appearance being rather against anything larger. Some riders pull at the handle-bar a great deal more than others, so that a tube which would be quite strong enough for one man would be bent at the first hill by another.

In the later days of the high bicycle, it was thought a great point to have the handle-bars wide, so that the handles were as much as thirty inches apart over the tips; but the gain was not only in the increased leverage helping to keep the wheel straight against the pedalling, but also in getting a fairly extended position for the elbow joints. The wide handle-bar was copied in the safety, partly, no doubt, on account of the difficulty experienced in steering the new type by old "ordinary" riders. The pedalling of the safety having comparatively little effect on the steering, the great leverage is not necessary, and the full reach can be obtained without great width. So the present reaction in favour of narrow handle-bars has not occurred any earlier than might have been expected. We do not think the handles should be nearer together, but rather a little further apart, than the shoulder joints; otherwise, the chest may be cramped when the arms are pulling at the handles; 22in. would seem to be a good width.

Another unreasonable arrangement of the handle-bar for roadsters, we are glad to say, is fast disappearing. It consists in "dropping" or bending down the ends of the bar several inches below the level of the centre. In order to bring the handles to a convenient height with such a bar it is necessary to raise it very high, and the power is wasted through a great length of tube both in bar and stalk. The bar should lie in a plane connecting the rider's shoulders with the top of the head, so that when he straightens himself the little necessary to get a fair pull at the handles, the pull will be withstood as directly as possible. This, in effect, would mean inclining the handle-bar slightly upward, but might mean too short a head and too sharp bending of the ends where the handles are fixed. A well-designed machine will have as much handle-bar stalk as seat-pillar stalk exposed when

properly adjusted to fit a rider of average proportions. A fair compromise consists in the "flat" handle-bar, which is not curved down, but is sloped downwards at the same angle as the handles themselves. We think it possible that some day the whole front frame may be remodelled, so as to give increased lateral rigidity and direct tying from the axle to the handles. If two rods be held, one in each hand, in the most natural way, it will be found that they incline upwards, and slightly towards one another in front of the holder. The handles should be placed in a similar position, *i.e.*, nearly parallel to one another, and tipped down a little at the back.

Handles of strong material, such as horn, should be bored so as to leave about 1in. solid at the end, and, having been driven on to the bar, should be fixed with a screw underneath, the head being countersunk and filed off smooth. Cork, being brittle, should be bored quite through, and should be cemented on. If the bar be roughed a little, the cement will hold the cork well, and there will be little fear of the handle slipping up. The ends of the cork should be protected by metal or vulcanite caps. The worst of cork is, it very soon gets dirty, and so does not look well, but this is a trifling defect, and can easily be remedied by a little sand paper. Ivory handles were quite fashionable at one time, but they are very expensive and liable to crack. We do not recommend their use. Celluloid looks just as well, and answers better. Rubber handles are very comfortable, give a good grip, and save the wrists from vibration. A machine fitted with them is not so liable to slip down when leant against a wall, nor do they damage a papered or plastered surface. Felt handles have some good points, but, personally, we find them warm to the hands, this being an advantage in cold weather. Whatever the material, the handles should be firmly fixed, as a loose handle may mean lost steering. Handles that have become moist and slippery with perspiration may produce a similar accident; hence it is often best policy to wear gloves. Handles are always made barrel-shape nowadays. They should be about 1⅛in. diameter; if smaller, they are apt to cramp the hands. Some riders like to leave go of the ordinary handles, and catch hold of the front part of the bar, when climbing hills. It makes a change.

Generally, by releasing the adjusting arrangement, and one or more of the brake joints, the handle-bar can be set round in a line with the machine, instead of at right angles to it. This is a convenience in stowing, and if the pedals be taken off as well, the machine will go into a space very little, if any, more than a foot wide, the footrests being the widest part. The machine will stand much better with the handles put in this position than when ready for action.

The arrangement for holding the handle-bar at the desired height is similar to that for holding a hollow saddle-pillar, described later on. Always see that the handle-bar is square with the machine, and that the brake works all right after altering the height or position of the handle-bar.

THE REAR FRAME.

This important part of the machine is required (1) to connect the rear wheel to the front frame; (2) to support the saddle on which the weight of the rider is placed; (3) to carry the front part of the driving gear; (4) to withstand the strains incident to driving the machine.

The Socket Tube should be about 8in. long and carry a casting, or, better, a steel stamping, at each end. Each casting or stamping forms both a lug for receiving the front end of the corresponding backbone and a case for receiving a hardened cup, forming a ball race for part of the socket steering bearing. If stampings are used, cups are sometimes dispensed with, but it is better to have them so as to secure the greatest hardness, which is particularly necessary here, as the wear is concentrated at the back of the top and the front of the bottom of the head. The parts must be put together truly, so that the steering will work freely without being loose, and so that the backbones lie in the same plane, and the tube must be strong enough to keep the parts true under all ordinary strains; it is usually about 1⅛in. diameter. The upper backbone may be of any diameter between ⅞in. and 1in. Of two tubes of the same length and weight, that having the larger diameter and thinner walls will be stronger than the one having a smaller diameter but thicker walls, provided the walls are not too thin. A very thin tube is more liable to accidental injury than one of thicker gauge, and a large tube necessarily involves larger, and therefore heavier, joints. Provided the thing be not overdone in the way of lightness, large tubes are a decided success and are to be preferred. The lower backbone should be of 1in. to 1⅛in. diameter, and should be directed towards the centre of the crank-axle, neither above nor below it. Taking a bird's eye view of the frame, it will be seen that to obtain the greatest lateral rigidity of the crank bracket, the bracket itself should form a strut in a girder, consisting of four tubes, two running forward from the ends of the strut and meeting at their further extremities, and two running backward, arranged in the same way, but owing to the necessity of inserting the hub of the back wheel between the further extremities of the back tubes, it is impossible to bring them to a point there, as they should be for this purpose.

However, that is no reason why the front tubes should not be brought to a point at their forward ends. Few people surely need

to be told that a triangle is not only the most rigid figure, but, practically, the only rigid plane figure. We hold then that if the lower backbone be duplex, the members should not run parallel or spread from the crank bracket, but should meet at the head. By spreading the tubes at the crank bracket and inclining them together towards the head, the strain on the tubes becomes less at right angles to, and more in a line with, their length, and one may say that a tube is infinitely stronger to stand a lengthwise than a cross-wise strain. The theory, no doubt, accounts for the construction of the "Elswick" safety, in which the lower backbone tubes cross one another, so that the one that starts from the right-hand side of the crank bracket is attached to the left-hand side of the head, thus getting the strain more into the lines of the tubes than even mere triangulation would, though we are not prepared to say that it is a better form of construction than a well-bridged triangle. In either case the question arises, are these two tubes as rigid as a single tube of the same weight would be? We think that the two smaller tubes, even thus specially arranged, would be as liable to deflect under the strain as the single large one. To overcome the deflections, the two tubes should be bridged together, the more complete the bridging the better the result. A lower backbone thus triangulated and bridged may be more rigid sideway than a single round tube, but it will, in all probability, be less rigid vertically.

Taking a side view of the frame it will be observed that the back part of the machine rests on the head and the ground. Placing the rider's weight on the top of the machine sets up a severe swaying strain, acting on a centre line, running from the head to the point of contact between the rear wheel and the ground. It will be noticed that the lower backbone nearly follows this line, and, as tube strenuously resists twisting on its own axis, this part of the frame is very well situated in this connection.

The Diagonal Tube, which at one time was in many cases absent altogether, and in some was represented (?) by tie rods, is now commonly of as large diameter as the lower backbone. It should run straight from the seat-pillar lug towards the centre of the crank-axle, and for the sake of appearance may well be set parallel to the head tube. It prevents the frame from sagging under the load, and being a strut cannot be replaced by a tie; it also affords a more or less rigid connection between the saddle and bottom bracket. Attempts have been made to support the bracket better by forking the diagonal tube and carrying the prongs to the ends of the bracket, but if anything is done in this way two separate tubes should be used, starting from the ends of the bracket and converging at the saddle-pillar lug, and the tubes should be stayed together by cross bridges. And though such triangulation might

be more successful here than in the lower backbone, as there is no axial twist and the strain is so much lateral, still the chances are that with the same weight of material as good a result can be obtained by using a single large tube.

The Back Fork is composed of two small tubes of from ½in. to ⅝in. and even ¾in. diameter. This fork carries a good deal of the load, and it also has a good deal to do with the lateral rigidity of the machine. The members should therefore be straight, and should be bridged above the wheel by a cross strut. The tops of the tubes are sometimes fixed, but are usually bolted to the saddle-pillar lug, and the feet are brazed to the fork ends; sometimes the feet are made with eyes, and rest on the axle instead of being secured to the fork ends. The tops should lie as close together as they can while leaving enough clearance on each side of the tyre, and keeping the tubes straight; if they project much they are liable to catch the legs, especially if the saddle be set far back. If the feet are brazed to the fork ends, they should join on at a point behind rather than forward of the centre of the slot, otherwise there will be a severe strain on the upper part of the fork-end when the axle is adjusted out to the end of the slot. When the feet of the fork are carried directly by the axle, the direct carrying of the weight is ensured independently of the movement of the axle, and so far this is good, but we think the advantage is outweighed by the disadvantages. In order that the frame may not be sprung when the chain is adjusted, the slot in the fork-ends is, or should be, made at a tangent to a curve having the centre of the bolt holding the tops of the tubes as centre; this means setting the fork ends at an angle to the back stays, which is decidedly undesirable. Further, as the feet of the tubes have to be passed on to the ends of the axle, the fixed bridge cannot be used, and as there are four bolted joints, the frame is apt to be less firm than if it were brazed together at all points. The bolt holding the tops of the fork must be loosened in order to adjust the chain, and this may let the saddle-pillar twist or drop. This construction is known as the "swinging" back fork.

The Back Stays—One of the earliest frames for the rear-driving safety was known as the cross frame; no doubt it will be familiar to most readers. A single backbone, continued in line by a strong fork, ran direct from the head to the centre of the back wheel; a single cross tube was set more or less in the position of the present diagonal tube, and carried the saddle at the top and the bracket at the bottom. Thu there was no direct support between the bracket and the back axle, and the bracket was consequently very unstable under the driving strain, twisting back under the pull of the chain when pressure was applied to the pedals. None too soon the necessity of

introducing struts or stays between the bracket and the axle to prevent this "giving" was recognised, and even then some makers fitted light wire rods, only suitable for ties, and these not straight. The evident benefit of the stays led to their being made stronger, so as to gain still better results, till they were made so powerful that it was seen that by raising the forward end of the fork to the saddle-pillar lug, a considerably improved frame might be obtained: the semi-diamond frame, a very excellent pattern, that for years had a large sale. Hence arose the terms, "back stays" and "back fork," which are now applied to the corresponding parts in the full diamond frame.

The back stays can hardly be too strong. In addition to forming a part of the weight carrying frame, they have an important duty to perform in holding the bracket at a constant distance from the rear axle, and in preventing its twisting. They should also be strong enough to prevent the bracket giving laterally as the pedals are forced down alternately. As the teeth of the chain wheel on the crank-axle usually lie to one side of, not between, the bearings, the stay on the chain side is in compression, and the other one is in tension; in any case the strain on the first tube is much greater than that on the other, and it may well be made of heavier gauge tube—$\frac{5}{8}$in. was the usual size for these tubes, but now $\frac{3}{4}$in. and $\frac{7}{8}$in. are common. We have already pointed out the strong desirability of having compression tubes straight in themselves and in their joints, and in no part of the machine is this more important than in the back stays, and perhaps in no other part of the machine are such decided attempts made to bluff the buyer. Another reason why these tubes should not be bent is that, being of very thin material to begin with, there is great risk of failure on the outside of the bend where the metal is stretched. The tubes should certainly be bridged together between the tyre and the bracket to increase the sideway strength, and if there are any bends, the bridge should lie between the crowns of them. The object of bending the tubes is to get the forward ends near together, and so allow of the chain wheel being brought close in to the centre and the feet working near together. No doubt a narrow tread, as it is called, is an advantage up to a certain point, but the idea should not be carried to such an excess as to involve weakness and friction. Even if the stay on the chain side is set in there is no particular reason why the other, though the far less important, should not be left straight. The disadvantage of having the fork ends set at an angle, as with the swinging back fork, is that it carries the wheel axle above the centre line of the back stays.

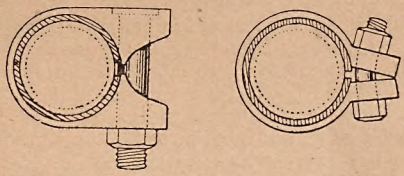
Almost any part of a machine may be made rigid by sheer mass of metal, but the more nearly the design is correct, the lighter the machine will be for its strength, and the stronger for its weight.

The Saddle Pillar is used to connect the saddle to the frame. It generally consists of two tubes held together at an angle—thus, ⌐, so that when one is telescoped into the top of the diagonal tube, the other will be horizontal, and lie lengthwise with the machine. The ideal saddle-pillar would rise vertically from the lug, and carry the saddle directly on the top, but this cannot well be managed, and the slanting pillar arranged as described is the next best thing. To allow for riders of different sizes, the pillar is made adjustable in the tube, so that the saddle can be fixed at different heights; the horizontal arm allows of the saddle being adjusted backward or forward. Sometimes the pillar is made thus, ⊤, to allow also for a very forward position for the saddle, but one cannot generally fix the saddle just at the joint between the two tubes. This defect has now been ingeniously overcome, and in future saddle clips and pillars will be obtainable that will allow of adjustment right along the horizontal arm. Saddle-pillars are also being introduced which have no horizontal arm, the saddle being clipped direct to the upright part, but these are not as a rule to be selected, unless the rider knows that this position for the saddle will suit him exactly. When a saddle is fixed to the end of a long horizontal arm, the strain is very considerable, and if some means of supporting the arm by both ends could be found, without counterbalancing disadvantages, it would be an improvement, but it does not seem possible to do it properly without upsetting the general design of the frame. The less the pillar projects above the lug the better, as it has less leverage on the frame, and it should never be drawn out so far as to leave less than 2in. of the pillar in the diagonal tube, otherwise the pillar may collapse. Some makers, and their number is fortunately increasing, build their frames in two or three different sizes, so that one may get a machine to fit him within a little, and tall riders need not jeopardise their safety on the top of a long pillar. Both parts of the pillar should be made of thick gauge tube; the diameter of the upright depends on the size of the diagonal tube; the horizontal arm measures from $\frac{3}{4}$in. to $\frac{7}{8}$in. in diameter.

Solid saddle-pillars, usually of $\frac{5}{8}$in. diameter, have almost gone out of fashion, though they have their advantages.

The arrangement for holding the saddle-pillar at the desired height should be of the set screw variety if the pillar be solid, and the split lug if it be hollow. In the former case the screw has a flat point and screws into the lug at right angles to the pillar and presses against it; the part of the pillar which the screw presses against should be flattened to prevent its twisting sideways. Of course a tubular pillar would be dented by a set screw, so for those the boss is formed on one side with a lug which is cut through, dividing it into two halves or ears; a screw bolt is fitted to draw the

two parts of the lug together, and so grip the tube without damaging it. The holes through the ears should allow the bolt to nearly touch the inner tube, as if the ears be long they are apt to bend. This bends the bolt and makes it difficult to turn, and one cannot



always tell whether this is the case or whether the cramp, as it is called, is tightened right up. If one turns further the bolt may snap, and if one does not the adjustment may be insecure and cause a spill. Care must be taken to see that the saddle points for the head tube, *i.e.*, is in line with the machine, before tightening up the cramp.

THE JOINTS.

The parts of the frame which connect the tubes together, in a word, the joints, are formed more or less nearly in their finished shape by casting or stamping. If cast they are usually made of malleable iron; if stamped, of steel. Malleable iron castings are much more reliable than they used to be, and several at least of the best firms use them regularly; if of really good stuff there is not much objection to them, but stampings are to be preferred for the more important parts.

As a general rule it is much better that the tubes should fit into the stamping, the tubes can then be butted right up to each other, and the strength of the joint graduated off. If the stamping be fitted into the tube there is necessarily a sudden step in the joint, which is a source of weakness. In the former case, too, there is a better chance of correcting any slight variation in the length of a tube without pulling it about. In selecting a machine it is well to look along the tubes to see that they have no irregular bends in them. The angles in a stamping should always be rounded, as square corners encourage breakages. By tapering off the joints to a thin edge, any very sudden strengthening of the tube is avoided, and there is less excuse for fracturing where the joint begins. The same idea is carried further in using "liners," that is, tubular plugs fitting into the ends of the tubes and extending some distance beyond the joints; sometimes the free end of the plug is serrated or split into long teeth, so as to make the accession of strength very gradual. Every head tube should be strengthened

by a plug or liner at the bottom, and it is a good thing to fit them into the tops of the fork sides; otherwise these liners are mostly used to strengthen very light frames. The parts of the tubes at the edges of the joints should be carefully examined, as there is danger of the tubes being filed thin there when the joints are cleaned up after brazing.

The bottom bracket is the most important joint, and it is almost always a casting; it would be much more expensive in itself and in the working if made as a stamping. The lower backbone, the diagonal tube, and the back stays all meet in it, and should all be directed towards the central line of the bracket. The bottom of the diagonal tube should be corked, as dirt may get in at the split at the saddle-pillar lug, or through the saddle-pillar if there be a hole right through it.

The joints at the rear extremity of the frame holding the driving wheel axle, and which are usually called the back fork ends, are frequently built up as inside joints, passing into the tubes instead of the tubes into them. They certainly look neater like this, but it is not the best way. The fork ends should be sufficiently strong to support the stays and axle, and should lie parallel to each other and at the right distance apart, so that they bear evenly against the backs of the cones and axle nuts. The slots should just fit the back spindle, or rather the shoulders on the cones, as, if too large, the wheel and frame may get out of position, and the nuts be difficult to operate; and they should be long enough to allow of the wheel being adjusted about $\frac{3}{4}$in. lengthwise. The slots should be directly in line with the back stays. The back forks should join on well towards the back of the "ends," and there should be plenty of metal forward thence to the stays; the lower parts of the fork ends do not get nearly so much work as the upper.

The backs of the cones and nuts on the front spindle should be a good size, so as to obtain a firm hold on the fork ends, especially if they be button-holed. This is often a weak point in a machine.

The fork crown very frequently consists of two plates fitted one above the other some distance apart at the top of the fork; the lower end of the head tube is also held by the same plates. The strength of this form of crown depends a good deal on the distance the plates are set apart, the further the better in moderation. If a solid crown be used it is generally in the form of a shaped bar or stamping having three parallel holes formed through it vertically. The middle hole takes the head tube, and the others receive the fork sides. If the middle hole be continued by a sleeve rising above the bottom ball race of the head, so much the better. There should be at least $\frac{1}{4}$in. clearance at the sides of the tyres and $\frac{1}{2}$in. to 1in. above them, to prevent clogging with mud.

The importance of distance between the plates of a plate fork crown is also applicable to the depth of all crowns. It is simply a question of leverage. Suppose the head tube to be a lever, the top plate to be the fulcrum, and the lower plate the resistance, then the greater the distance between the plates the more force will be required to overcome the resistance. The same with the fork sides. And so the greater the distance between the plates the stronger the crown, and it is in effect the same if the space between the plates be filled in with metal; in other words, it is the same with a solid crown. A solid crown should never be lightened by taking the metal out of the top or bottom of the parts between the tubes. The edges of the plates should be thickened around the tubes to afford large brazing surfaces, and this without undue complication.

The lap joint is formed by belling and shaping the end of one tube to fit against the other. Well made it forms a good and light joint, no casting or stamping being used. It is not so often employed now as it used to be, but is sometimes used at the T joint between the stalk and handle-bar. A modified form of the lap joint consists in making the joints separately of short pieces of tube and fitting them on to the ends of the tubes as in an outside stamping joint; this should make the joint stronger. It is sometimes imitated in stampings.

THE HEAD

is practically the hinge which allows of the front wheel being turned either in the direction in which it is desired to go, or for balancing. There is now practically but one type of head, the socket, and it is almost always made to work on balls.

In the plain socket head a sleeve, known as the socket tube, is attached to the front ends of the backbones. This sleeve fits round the spindle or head tube, rising from the crown of the front fork. Sometimes there is a coil spring put between the lower end of the sleeve and the top of the fork crown, and less often another between the top of the crown and the sliding piece on the pillar above it. The use of this sliding piece is to take up wear to some extent, and the use of the springs is professedly to reduce vibration, but as they affect the rear frame only (not the handles), and that very slightly, they are probably more useful in avoiding rattle. The principal advantage of the plain socket head is its strength; and the steering line is brought well forward without increasing the angle between it and the ground. Its disadvantages are that it requires frequent and plentiful oiling; if the oiling be insufficient it will heat, and, swelling, lock, so that the machine will not steer. These disadvantages are absent in the ball bearing socket head, which is probably the best kind. It differs from the plain variety in that it does not bear on the head tube throughout the length,

but at the ends of the sleeve, where it is provided with rows of balls, one row at each end. This head requires little oil (though means should be provided for injecting it); it is not apt to lock, and the wear, which is very slight, may be easily compensated by adjustment. The steering is both steady and free, and the advantage of the special position of the centres line is the same as in the plain socket head.

Nine inches is a very good length for the head; if it be too short the fore and aft strain on it is greatly increased, if it be too long the head tube and socket tube are, especially in a light machine, liable to be bent; this upsets the relative positions of the bearing parts and spoils the steering.

The lamp bracket, head adjustment and handle-bar adjustment, are sometimes all held by one bolt, but this is bad, as an alteration of one necessitates attention to all.

THE BEARINGS.

Bearings occur where a moving part of the machine comes in contact with a part that does not move, *e.g.*, at the hubs and spindles and at the head. If no special arrangement were made there would be great friction between the parts, involving hard work, wear, and fracture; bearings are, therefore, so constructed as to diminish the friction, making it as easy as possible for the rider to propel the machine. In this connection it may be noticed that friction may be dealt with in two ways—(1) by distributing it, and (2) by placing a revolving body or bodies between the two moving parts, *e.g.*, the rollers that are put under safes and other heavy objects, which enable weights to be moved by an amount of power that would be totally inadequate in their absence, and so it is in the bearings of cycles. The best bearings are constructed not with plain surfaces working directly on each other, but with balls between the surfaces, which are grooved in such a way as to prevent the balls escaping, and so as to allow of adjustment being made to compensate wear. Indeed, apart from the bearings, the practicability of the cycle itself may be said to depend on this fact: the wheels of the machine, which correspond to the rollers, being placed between the weight (the rider and framework) and the road, the weight being propelled by the same amount of power about three times as fast as if it were dragged along the ground direct, as in walking.

A bearing is composed of two principal parts, the spindle and the case or box. Ball bearings have a third part, viz., the balls which work between the other two parts. Bearings of cycles may be divided into two classes—(1) Those in which the case revolves and the spindle does not revolve, *e.g.*, the front wheel hub of the rear-driving safety; (2) those in which the spindle revolves and the case does not revolve, *e.g.*, the crank-axle bearings.

The best relative shapes and sizes for the different parts of ball bearings are not yet definitely settled, but it seems pretty certain that the inner ball race, that is, the part of the axle on which the balls run, should be as small as it can be consistent with strength and rigidity. A weak axle or case causes friction by allowing the parts to lose their proper relative positions, therefore a light axle should be supported close up to the ball races.

Very large bearings certainly run badly, perhaps it is because the friction acting at a greater distance from the centre has more leverage. Then arises the question, is it better to have a large or a small ball race in the case? If large, the balls must be large to fill up the space, and it will take but a few to form the ring; if small, the balls will be small, but there will be more of them. The larger the ball the slower it revolves, the more surface there is to wear, and the less liable it is to get crushed. Though more small balls can be used than large, it does not perhaps follow that the friction is proportionately distributed; the ball for the time being crossing the line of greatest pressure takes most of the work, and so long as there are enough to keep the parts up to their work that is sufficient. Small inner ball races and large balls appear to be theoretically correct, and practice points to the same conclusion. We prefer $\frac{5}{16}$in. balls for the driving wheel and crank-axle bearings, $\frac{1}{4}$in. for the front wheel, and $\frac{3}{16}$in. for the head and pedals.

To get the best results out of the balls the respective ball races should be horizontally parallel, so that the balls touch only at the ends of those of their diameters which are radial to the centre of the bearing. Such a bearing would provide no steadiness sideways, and would be incapable of adjustment by the best method.

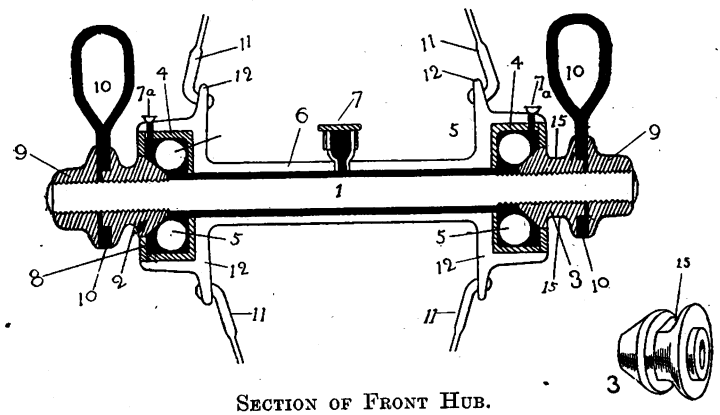
The bearings of both wheels and the crank-axle are all subject to considerable lateral as well as vertical pressure, owing, in the case of the wheels, to the machine not being always exactly vertical under the rider's weight, and, as regards the crank-axle, to the power being applied alternately first to one pedal and then to the other. Now it is obvious that if the only bearing contact between the hub and spindle were on a narrrow surface in the centre, directly the machine was moved in the least from a vertical position the bearing would be subject to a cross strain, which would bind it more and more as the weight leant further over. It is also obvious that the wider the bearing the less effect this cross strain would have, and further that, supposing the parts to be rigid, the result would not be prejudiced by reducing the bearing surfaces so long as the extreme width over all were not diminished.

Hence the bearings of cycles are almost invariably constructed with two rings of balls set at a considerable distance apart, each ring having its own ball races. This gives lateral stability, but it

does not provide for taking up wear. Of course if wear could be prevented instead of cured, so much the better, but even then provision would have to be made for obtaining the right adjustment in the first instance. The bearing parts should be turned from bar steel (not stampings) of suitable quality, hardened so that a file can't "touch" them, and ground perfectly true after hardening; all traces of nickel plate, enamel, etc., should be removed before the bearings are put together. The balls should be perfectly spherical, dead hard, and all of precisely the same size; they should not fill the circle exactly, but there should be, say, $\frac{1}{16}$in. to $\frac{1}{8}$in. extra space, so that each ball will be free to move and not be jammed by its neighbours.

A bearing good in itself may be made bad in effect by being badly attached to the machine. The attachments must be firm enough in themselves to withstand any strain or vibration they may be subjected to; at the same time they should be so constructed that if the wear is not equally distributed round the bearing, but is most at certain points (*e.g.*, at the top), the parts can be turned round so as to equalise it, and so that if the frame springs or gets bent the free running of the bearing is not interfered with.

The cut below shows the usual form of *front wheel bearing* (of



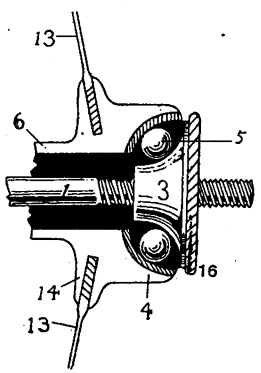
SECTION OF FRONT HUB.

1—Axle or spindle.
2—Fixed cone.
3—Adjusting cone.
4, 4—Cups.
5, 5—Balls.
6—Hub centre.
7—Lubricator.
7A—Lubricator.
8—Oil retainers.
9—Axle nuts.
10, 10—Front fork ends.
11, 11—Tangent butted spokes.
12, 12—Flanges for ditto.
13, 13—Direct butted spokes
14, 14—Flanges for ditto.
15, 15—Flats.

the first class mentioned above). It will be noticed that the

spindle has two cones on it, the apexes of which point towards one another; one is fixed by being screwed on tight up to the end of the thread, and the other also is screwed internally, but so that it may be adjusted along the spindle. The interior of the hub is formed with hardened cups at the ends, and the balls are fitted into the annular spaces between the cups and cones. The moving cone is provided on the outside near the end with a milled edge or with flats, so that it may be turned round and so moved along the spindle. If it be screwed along towards the other cone, the rings of balls will be carried nearer to each other, and the balls in each ring will be set out further from the centre so as to form a larger ring; this will tighten the bearing both laterally and vertically. The shapes of the ball races are very important. Points further from the centre (of rotation) of the ball travel faster than those nearer to it, so if a ball be rolled along in a groove fitting part of the curve of the ball there will be sliding friction as well as rolling. To avoid this the balls should touch the races at points only.

The races are sometimes constructed thus:



1.—Axle.
3.—Cone.
4.—Cup.
5.—Balls.
6.—Hub centre.
13, 13.—Direct butted spokes.
14.—Flanges for ditto.
16.—Milled collar.

So as to get the ball to touch at two points only, and to have these diametrically opposite to each other (which is certainly desirable).

It might answer very well if the pressure were equal in every direction, but as it is usually confined almost exclusively to one or two directions, the long slopes must surely set up a wedging action on the balls and cause excessive friction. The contact surfaces in the first figure are smaller than in this. Further, there are three of them, and a line joining the two on the cup lies parallel to the rectilineal surface of the cone, so that there should be no tendency to wedge. There is a disadvantage in that the effective diameter

of the ball is reduced to the distance between the line and the surface of the cone.

If the adjusting cone be screwed in far enough, it is obvious that the hub may be jammed tight, and the wheel thus be prevented from revolving at all, while if it be screwed out a little distance, the hub (and wheel) will not only be able to revolve, but also to move sideways. When the hub is so loose at this the bearing may cease to be taken by the balls, and the cups will run direct on the cones, making a short ill-fitted plain bearing; this is especially liable to occur with closely-fitted dust-proof bearings; the steering of the machine, too, may be rendered less accurate. The cone should be screwed in just so far that the hub can revolve freely with but the least looseness sideways. The moving or adjusting cone should be on the left side of the machine, so that if the lock-nut loosen the friction will tend to loosen the bearing; if fitted on the right-hand side, the friction would screw the cone in and tighten up the bearing until it stopped the wheel, with results that will be readily imagined.

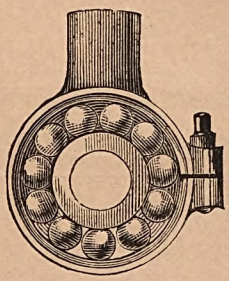
Cup lubricators are usually fitted in the centre of the hub, but if the bearings be extended as shown, lubricating holes may be placed outside the wheel immediately over the balls; this ensures both rows of balls getting their proper supply of oil. A single lubricator placed in the middle of the wheel is very awkward to reach, especially with gloves on, and besides, being a long way from the balls, the oil is pretty sure to run mostly to one row. The best hubs are now made with flat rings (8) spun into the ends of the cups; these keep the oil in and the dust out.

It will be noticed that the cone in the last figure has a projecting milled collar that forms a groove at the end of the hub. This is a bad arrangement, as grit is sure to lodge in the groove, and is very apt to work into the bearings, where, of course, it would cause friction. Attempts to wipe it away are almost sure to result in brushing it in instead. The cones should be constructed as in the former figure, then the grit cannot lodge anywhere whence it can work into the bearings.

In the same figure the bases of the cones and the nuts are flanged out to get a good hold on the fork ends. On the bases of the cones are slight projections or shoulders on which the fork rests, instead of bearing directly on the spindle. The shoulder on the adjusting cone should be round, so that it may be turned to any position, but the shoulder on the fixed cone should be square, so that it and the axle cannot turn round when the nuts are loosened, and yet so that they can be set in four different positions, allowing the wear to be distributed fairly round the cones. Of course, the holes in the fork ends should be round and square to match. The shoulders must not come right through the holes, or the nuts will have no grip on the fork.

To exclude grit from the bearings, worsted thread, or, better, some chenille, may be wound round the cones between the hub and the fork ends. It should not be jammed in so tight as to impede the wheel.

Back Wheel Bearing.—If this be of the first class the above remarks will apply, but a few machines are fitted with back wheels having rotating axles turning in a pair of bearings fixed to the frame of the machine (*i.e.*, they are of the second class). In this case there are two bearings to adjust instead of one, but each is done in the same way. It will be noticed that the axle has a grooved collar or sleeve on it. The case is formed of three principal parts—(1) the fixed disc, (2) the adjusting disc, and (3) the outer case. The two discs are cupped, so that when

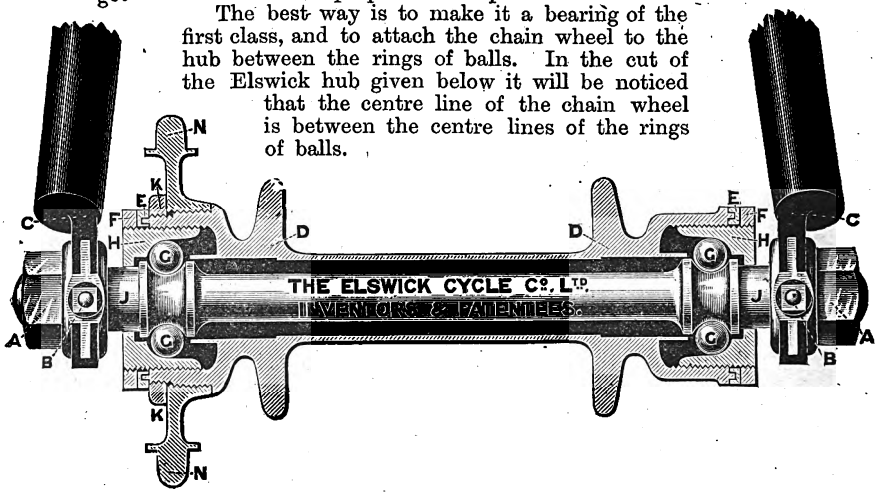


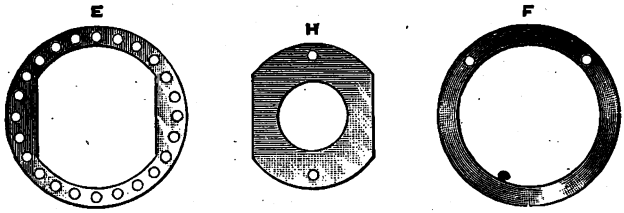
brought face to face they form a groove, and, with the grooved collar on the axle, a hollow ring, in which the balls run. We do not recommend this construction. The balls form the only connection between the two fork ends, and the bearings are therefore subject to great strains. It is always difficult to get two bearings perfectly true with each other on one axle, and it is also difficult to adjust them properly. The adjusting discs should both face one way, otherwise adjusting the bearings tends to force the balls out of the grooves. The only good point is that it allows the pull of the chain to come between the rings of balls.

An elementary mechanical fact is this, that if power is to be applied to a revolving shaft (or hub), the point of application should be between the bearings, and not to one side of them. The reasons are simple enough: If the power be applied between the bearings, the shaft is supported on both sides, and the strain on both bearings and both supports is alike. But if the power be applied to a part of the shaft that is not between the bearings, it

(the shaft) is at this point supported on only one side, viz., the one on which the bearings are, and the strain on the bearings, &c., instead of being even, is crossed, *i.e.*, it is pulling on one and pushing the other; this increases the friction, more especially if the power applied be great, and causes the bearings to wear unequally, and the more they wear the worse it gets, as the parts get further out of their proper relative positions.

The best way is to make it a bearing of the first class, and to attach the chain wheel to the hub between the rings of balls. In the cut of the Elswick hub given below it will be noticed that the centre line of the chain wheel is between the centre lines of the rings of balls.





A, A.—Axle nuts.
B, B.—Chain adjusters.
C, C.—Back fork ends.
D, D.—Flanges of hub.
E, E.—Adjusting rings.
F, F.—Adjusting nuts.
G, G.—Balls.
H, H.—Bearing cups.
J.—Axle.
K.—Chain wheel nut.
N, N.—Chain wheel teeth.

Though this is a bearing of the first class it is arranged on different lines from the front hub previously described. The cones are turned solid on the axle, and in effect face outward, and the cups screw mouth inward into the ends of the hub, their backs

coming well down to the axle to exclude dust. The length of the aperture for the entrance of dust is as small as it can be; it corresponds to the circumference of the axle; in the former case it corresponds to the circumference of the cup. On the other hand, the risk of shake in the adjusting part (in this case the cup) is reduced to a minimum, as it is on the external circumference, while in the first case, the thread being on the internal circumference of the adjusting part (the cone), any looseness at the thread means increased shake at points nearer the external circumference.

This form of bearing is more difficult to make than the other, as the spindle is very liable to warp in the hardening. It is particularly suitable for the back hub, as it allows either the hub or the chain to be adjusted without interfering with the other.

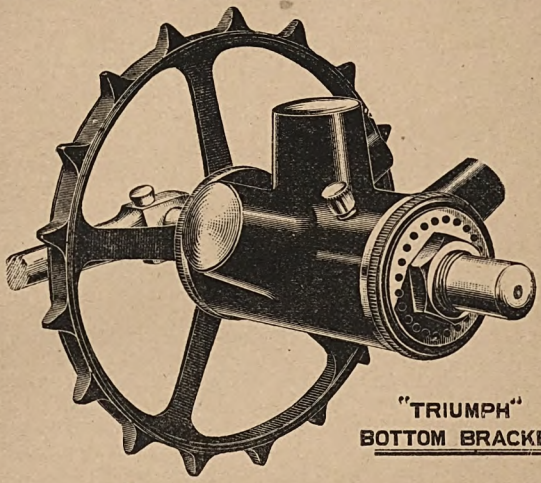
The Crank Axle Bearings or Bottom Bracket Bearing.—As the cranks are attached to the crank axle these bearings are necessarily of the second class. They may be constructed on either of the principles represented in our cuts of the front and back hubs. If like the front hub, as the axle revolves, the adjusting cone must either be on the right hand side of the machine, or if on the left it should work on a left hand, instead of a right hand screw thread; and as there is no intervening fork-end, the method of locking the cone is necessarily different. The most usual method is to make the screwed part of the axle of **D** section, that is, with a flat on it; next to the back of the cone is placed a washer with a corresponding **D**-shaped hole, and then one or even two lock nuts. The object of **D**-ing the two parts mentioned is to prevent the cone turning when the lock-nut is turned, but it is seldom perfectly successful. A better method is that adopted in the Triumph bracket, in which a pin in the back of the cone engages with one of a series of holes round the edge of the washer.

For a long time the bracket, or case, used for this class of bearing was on the lines of a hub with contracted centre and enlarged ends, but when the Humber barrel bracket came out, its cylindrical exterior was quickly copied. If the bracket be of this shape, a light tube should be fitted between the backs of the cups, and the lubricators should be connected to this tube, otherwise most of the oil will get down into the bottom of the bracket, where it is useless, instead of to the balls.

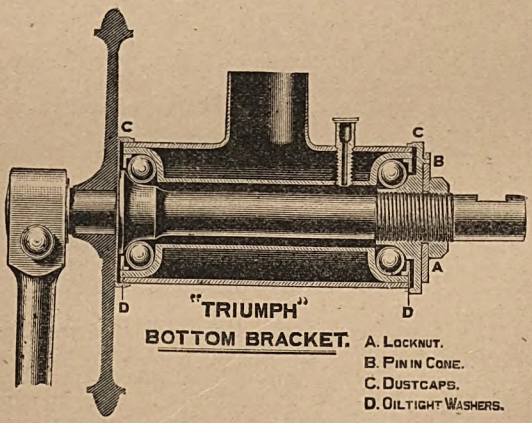
The Triumph bracket and some others are fitted with dust-caps that revolve with the axle. Another method is to fix dust-caps to the ends of the bracket, with central holes fitting round the axle, but there is some difficulty in fixing them to the more important end, that next the chain wheel. Hubs are often dust-capped in these ways.

In bottom brackets, constructed on the Humber principle (like the Elswick hub), there is considerable diversity in the ways of

locking the cups. We do not know that we can single out any method as the best. The locking must be firm, and it must allow of practically infinitely small movement; it must not throw the



"TRIUMPH"
BOTTOM BRACKET.



"TRIUMPH"
BOTTOM BRACKET.

A. Locknut.
B. Pin in Cone.
C. Dustcaps.
D. Oiltight Washers.

parts out of position, or damage the threads, or add materially to the width of the bracket, or allow dirt to enter the bearing (the slots in the split-lug method are often cut too far, and so admit dirt thrown by the front wheel).

The advantages and disadvantages of his principle have been indicated above, and on the whole we certainly prefer it to the other. But the purchaser must remember that a parallel bracket does not necessarily mean a Humber principle bearing; close inspection is often necessary before the difference can be detected from the exterior.

The crank-axle bearing is subject to the backward pull of the chain, and to the alternate pedalling strain. As the rings of balls in the bracket cannot be placed right under the respective pedals, a certain amount of side pressure and leverage on the bearing is unavoidable. To minimise this, the pedals should run as close as possible to the cranks, the cranks kept straight (not bent out), and the rings of balls brought out as near to the cranks as possible. Not only so, the rings of balls must be a good distance apart, certainly not less than three inches.

The pull of the chain is necessarily, to a great extent, one-sided, and unless properly withstood the bracket will twist and let the chain-wheels cross. If they do this the chain will be bent sideways, and will not run freely; further, it may cease to gear properly into the teeth of the wheel, and, mounting, twist the frame, and then come off if it does not break. This twisting may be considerably prevented by using powerful back-stays, but it may also be cured to some extent by getting the teeth of the chain-wheel between the bearings. This has been done with some success by mounting the crank-axle in two separate bearings, and fixing the chain-wheel between, but it is subject to the disadvantages before referred to as attendant on the fixing of two separate bearings on one axle, and it causes a departure from the usual excellent design of frame, which is disadvantageous in some respects, though it allows of using straight back-stays leading direct from the rings of balls. Next to combining the two separate bearings into one single one, the best plan is to use a dished or overhanging chain, which, though it has its centre fixed to the axle outside the bearings, has its ring of teeth lying between them, but this arrangement sacrifices the direct back-stays. If the wheel cannot be made to overhang the bearing it should be got as near to doing so as possible; the cross strain increases greatly as the wheel is removed further away.

The Pedal Bearings are generally constructed like the front hub illustrated, but the adjusting (outer) cone is locked by a D washer and nut. The fixed (inner) cone is generally turned in one piece with the spindle, and is frequently left soft for fear of making it brittle, but some means ought to be found of providing a hardened ball race at this end. The spindle should be covered by a centre tube, and the two bearing cups should be turned in one piece with the tube; if separate, they are very liable to get out of truth

relatively. The centre tube keeps dust out of the bearings, and the outer end of the spindle should be covered by a dust cap. The cup nearer the crank should be well sunk into the plate, so that the pedal can run close up to the crank, thus narrowing the tread and reducing the leverage on the axle bearings. Pedals are not always so well made as they might be, and efforts to produce a thoroughly good article have not received due encouragement.

The Head also is constructed in a similar way. A hardened cone is secured, apex upwards, round the bottom of the head tube, the ends of the socket tube are cupped, and an adjusting cone is fitted apex downwards at the top of the head tube. This cone sometimes slides on the tube, and is pressed down by a thin circular nut screwing on a short screw cut on the top of the tube, and it is locked in the desired position by a bolt tightening the parts of a split lug formed on it, the one device holding the handle-bar at the desired height also. Though neither the head nor the handle-bar require frequent adjustment, we think separate locking arrangements are desirable. There should be provision made for lubricating both rings of balls, and the parts should overhang to exclude dust.

THE DRIVING GEAR.

Attempts have been made to fit the cranks and pedals to the rear-wheel axle, gearing the wheel up by bevel gear contained in the hub. This necessitated a very backward position for the saddle, but to prevent tipping up the front wheel it could hardly be fixed behind the centre of the rear wheel. The machine did not take very well; perhaps hesitating buyers came to the conclusion that they would rather do their swimming in the water, as of old. To get the pedals further forward, a short axle carrying a chain-wheel was fixed to each back-stay, and two chains geared with the chain-wheels on the hub, but there was too much twist on the short axles. The present system overcomes both difficulties. The cranks (or levers) carrying pedals at their outer ends are both fixed to one axle, which has a fairly wide bearing. A large chain-wheel is fixed to the crank-axle, a smaller wheel, in line with the larger, to the hub, and an endless chain communicates rotation from one to the other.

Nothing can be much simpler than this, and any attempt to reduce the work by complicating the gear must necessarily fail. No gearing (as distinct from a motor) gives power. One cannot get more force out of one end of a system than is put in at the other. It is not a question of creating power, but of saving loss, so that the addition of gearing, which involves more friction or more weight or less rigid framework, is at least correspondingly disadvantageous. Each system must be treated as a whole; it is no use looking at one part only, which, so far as it goes, may be an

improvement, and neglecting another part which is necessarily impaired by the alteration. And one must consider a trial complete from start to finish; a machine fitted with a fly wheel would very likely outrun another after driving had ceased on both, but the fly wheel has required labour to be expended in setting it going that was not called for on the other machine.

Improvement must be looked for, not in making additions such as extra gear wheels, but in improving the details of the essential parts that already exist. If a new system with less friction and weight can be found, it may be a success, but none has become general yet. The gearing at present used fulfils two objects—it connects the pedals to the driving wheel, and it gears the driving wheel up. The connection accounts for most of the weight and friction, but the gearing up involves almost none. We do not see how gearing up can be effected with less waste of power than by making merely of different sizes two wheels which are already present. In other systems of gearing, the gearing up frequently involves friction and weight apart from those arising from the connection of the parts. Perhaps lever driving gear with clutch drums and straps may have a chance.

The crank-axle should be of Bessemer steel, and not much less than $\frac{5}{8}$in. thick at its smallest part. It should be situated about 12in. off the ground; this allows of a long crank throw, and yet renders the probability of catching the pedals on stray stones or bricks on the road, or against the road itself in turning a corner sharply, very remote. The axle should be about 5in. to 6in. long. A short crank-axle does not necessarily imply a narrow tread, as the cranks and pedals are sometimes set out, thus putting the feet further apart, but it often does mean that the crank-axle bearing is too narrow.

The Cranks are generally bars of mild steel attached to the ends of the crank-axle, and by them the pressure on the pedals is communicated through the axle, front chain wheel, chain, back chain wheel, hub, flanges, spokes, and rim to the tyre, *i.e.*, there are ten or a dozen parts through which the power has to pass before it reaches its final destination. We need point to nothing more striking than this when we emphasise the necessity for rigidity in the parts themselves, and in those other parts which support them in their relative positions. The cranks should be strongest where they are attached to the axle, and lightest near the other end to which the pedal is attached. This lighter end is flattened out, and a hole or slot is cut through it to receive the end of the pedal pin. If a slot be provided, it allows the pedal to be set at various lengths from the axle; this length is called the "throw," and a crank is measured by the extreme length of throw the slot will permit of. Thus a 6½in. crank is one which allows the

pedal pin to be set 6½in. away from the axle, measuring from the centre of the axle to the centre of the pedal pin. A slot 1in. long will only allow of 1in. adjustment less the thickness of the pedal pin, that is to say, only about ⅝in. or ½in. actual adjustment.

Generally nowadays the cranks have only holes instead of slots into which to fit the pedal spindles. There is less risk of the pedal slipping with this arrangement, but the chances are that the throw provided will not exactly suit the rider, so that unless the machine is built for the use of one person only, and the pedals are fixed at his own particular reach, we prefer the slots, as they enable the rider to find what length suits him best. When he has found it he should mark it carefully. Sometimes the body of the crank is made of tube either oval or rectangular in section, the ends only being solid. Round solid cranks were popularised by Mr. F. Southard. He found that by twisting the steel cold on its own axis it was possible to get the necessary rigidity from a very light bar. Round cranks not prepared in this way are sometimes weak and springy. The round metal looks neater than the rectangular and holds the plating much better. Cranks are either attached so as to be permanently fixed, or are detachable at the will of the rider. In both varieties a hole is made in the boss of the crank the size of the end of the axle. In a fixed crank a flat about ⅜in. wide is formed on the axle lengthwise, making it somewhat D shape in section. A rectangular groove the same width as the flat and about ⅛in. deep is cut lengthwise in the hole in the boss of the crank. If the axle be made with a shallow recess instead of a mere flat, all the better. The crank is put on to the axle so that the groove and the flat make a four-sided rectangular-chamber. A steel key or wedge is then driven tight into this chamber, locking the crank and axle together. The key requires to be a very good fit, or it will soon work loose and lead to constant trouble until a new one be put in.

Starley's patent detachable crank is now fitted as follows: The crank fits on the end of the axle as in a fixed crank, but the keyway, instead of being longitudinal, is transverse, *i.e.*, it cuts partly through the crank and partly through the axle at right angles to the axle. A taper key, or cotter, with a screw-thread on the small end, is driven into this transverse keyway, and when tight, a nut is screwed on to the small end to prevent its shaking loose. On no account should it be attempted to tighten the key by turning the nut, as the almost certain result will be not to tighten the key but to strip the thread off the screw.

As the two **Chain-wheels** are parts through which the rider's power is transmitted from the pedal to the tyre of the driving-wheel, they require to be strong in themselves and in their fixings. It is not merely the rider's pressure they have to withstand as a

rule, but a good bit more, as the crank throw is greater than the average radius of the chain wheels. What are the best sizes for the respective wheels is a nice question. For large-size chain-wheels it is rightly claimed that having more teeth the wear is better distributed, that as the circle is larger the joints of the chain do not have to bend so much in passing round it, and that there is less strain on the chain, and consequently less friction in the joints and against the teeth of the wheels. Small wheels, on the other hand, are stronger for their weight, and are lighter, not only in themselves, but because they require a somewhat shorter chain. When the chain stretches so as to get out of pitch with the wheels, the defect is perhaps less felt with small wheels than large, and in some cases the frame of the machine can be built a little closer, and therefore stiffer, about the crank-axle if the wheels are small. A chain with two joints to the inch will wrap round a small chain-wheel better than a single-link chain, *i.e.*, one having only one joint to the inch. Most of the above remarks apply with a good deal more force to the small chain-wheel on the hub than to the larger one on the crank-axle, though one tooth on the former means, roughly, two on the latter. Taking a general view of the whole question, we are inclined to think that, other things being equal, the happy media will be found in the following: The chain-wheels on the hubs of roadsters should have ten teeth for single-link chains and nine for double. Light roadsters may have one less in either case, but we are doubtful if it be wise to go below this even with racers. Both the chain-wheels should be dead true sideways, and also on the circumference. If out of truth laterally, the chain will be apt to run off the wheels; if not round, the chain will be tight when the wheels are in one position and loose when in another. The teeth should be cut by machinery, and be of good shape.

Several attempts have been made to introduce elliptical or oval chain-wheels in place of the present round ones. A rider is not able to apply so much power at the top and bottom of the stroke (though both feet should be at work there) as he can about half-way down, as is observable when the resistance is nearly equal to the rider's extreme power, *e.g.*, when climbing a very stiff hill. The object of the elliptical wheel is to equalise the pressure, so that the pull on the chain shall be constant, and so fall in with the speed of the machine, which is more nearly constant the faster it travels. The oval wheel should be so fixed to the axle that its longer diameter is at right angles to the top run of the chain when the crank is at the point of greatest power, or, rather, greatest advantage, and that is when it is at about twenty-five degrees above the horizontal line on its downward course; then when the wheel has turned a quarter, and the rider is able to apply the least power, the shorter diameter will come into action. Suppose the machine to be

geared to 56in., and the two diameters to be in the proportion of 9 : 7. When the power is greatest, the longer diameter will come into action, and the machine will be in effect geared to 63in., and as the power decreases the wheel will gradually gear down until the shorter diameter comes to be at right angles to the pulling part of the chain, and the gear is reduced to its lowest effective limit of 49in. This may seem rather a great difference, 14in., but the crank travels faster at the low gear and slower at the high, thus giving more time to apply the requisite greater power, and moves quicker while the work is easier; further, these are the extremes which are only just touched, during the bulk of the time the gear is rising or falling between these two points. This system of gearing has the advantage that the alteration is most felt when it is most wanted, viz., when hill climbing, and at other times, when the hardness of the work reduces the speed. At very high speeds the irregularity in the pace of the crank may be disagreeably noticeable, though it was Johnson's extraordinary American mile that brought the idea into prominence recently. Its want of popularity here is probably owing to its having been tried on higher instead of usual gears, so that its benefit was not of course conspicuously apparent. It appears to be the most hopeful modification of the present system of gearing. The unequal tension of the chain is not a troublesome matter if the rider be a decent pedaller.

The best positions for the chain-wheels would be in the centre of the machine, each being set midway between its supporting bearings, but as the chain and driving wheel won't agree to this the gear must be put to one side of the machine; it does not much matter which. As most riders walk on the left side of the machine the chain is less liable to soil the garments if put on the right side; but most riders, again, are stronger in the right leg than the left, and this inequality may, perhaps, be compensated by putting the chain on the left side, as the chain wheel being nearer that side there will be less spring between it and the left (weaker) foot than the right (stronger) foot.

The larger chain wheel (for we presume no one ever had a rear-driving safety geared level or down) at one time was always of malleable cast iron, but now that stamped steel wheels are to be had they should always be used. Anyhow, the wheel is formed with a boss in the centre, and it is keyed on to the axle like a fixed crank, or it may be brazed to it. The rim of the wheel is supported on spokes from the central boss, and has around it a number of equidistant radiating teeth which are shaped to gear into the chain, according to the pattern used.

The spokes should be flat, their width lying in the plane of the wheel. The teeth should not, from a side view, represent a rectilineal triangle; they should form double curves, and a front view

should show the top corners rounded off, so that the teeth may enter the links of the chain easily, and not cause the latter to ride up on them. Unless the teeth are properly set out, they will not enter and leave the chain freely, and unnecessary friction and wear will take place. Sometimes, instead of the wheel being a single solid piece, it is built up of two or more parts, the rim and teeth being separate from the central boss. This is done either to obtain lightness or to enable the rider to alter his gear by attaching a larger or smaller rim to the one boss already fixed on the axle. Another way is to make the arms or spokes in one with the crank and to attach the ring of teeth to these arms. The wheel thus occupies no space on the axle, and the bearing can be extended right up to the crank. Great care is necessary to ensure these rings being truly concentric with the axle, and if they are attached to the arms by screws, it is better not to let the driving strain come directly on the screws; the arms should be let into recesses in the web of the ring.

The smaller chain-wheel should also be of steel, and fixed to the hub, generally by screwing on and fixing with radial screws or a lock-nut, as shown in the cut of the Elswick hub, but if only one chain-wheel be made detachable, it should be the one on the hub, as this one gets about twice as much wear as the large one, and it is, therefore, likely to require renewing first. When a detachable chain wheel is screwed on, it should be so arranged that driving will not loosen it; at the same time, we do not mean that it should screw on tighter and tighter the further one goes, as it is apt to get so jammed that it ceases to be detachable except in name, and even with proper tools there is a risk of pulling the wheel to pieces in trying to remove the chain-wheel.

The Chain is composed of links joined together so as to form an endless flexible metal band, and is fitted round the two chain-wheels engaging with both. The rotary motion imparted by the feet to the wheel on the crank-axle is transmitted through the chain to the chain-wheel on the hub of the driving-wheel. The strain on the chain is very considerable, and some friction is inseparable from its use; but not nearly so much now as in the earlier days. It should be not only strong enough to bear any tension it is subjected to, but so rigid or non-elastic as not to absorb power by springing. The friction arises in two places, one where the parts of the joints in the chain rub against one another, and the other where the links of the chain move on to the teeth of the large and off the teeth of the small one. The joints should have as long bearing surfaces as possible, and the parts be well fitted, properly hardened, and well lubricated. For if the chain have short bearing surfaces, and the parts be soft and badly fitted, it will run very stiffly, wear and stretch quickly, and soon get out of pitch with the wheel,

especially if the latter has narrow teeth. The stretching can be compensated to some extent by moving the chain-wheels further apart, but this will only answer up to a certain point; after that has been reached the chain will be liable to ride up on the teeth (instead of falling into place between them) and come off the wheels. The only remedy lies in a new chain. There should be no need to interfere with the adjusting arrangement in order to remove or replace the chain. In the event of fracture it would be convenient to be able to insert a new piece for the broken one on the spot without resorting to the repairer. Moreover, the chain should not be unnecessarily heavy.

It is desirable that the number of links in the chain should *not* be a multiple of the number of teeth on either of the chain-wheels, otherwise certain links will get more wear than others. The chain will stretch unequally, and it will be impossible to adjust it satisfactorily. When this defect exists, the position of the chain on the wheels should be altered frequently, so as to equalise the wear so far as possible. Thus, if there were eight teeth on the hub wheel and sixteen on the crank wheel, there should not be exactly forty-eight links in the chain, as the chain would be in precisely the same position at every third revolution of the crank-axle, and every sixth of the back wheel. In this case, so far as the chain is concerned, forty-seven or forty-nine would be the best number of links, as neither of these numbers being a multiple of eight or sixteen, or any factor of either of them, the wear on the chain would be evenly distributed to each link.

The kinds in most general use are known as the Humber or block, and the roller, the former having been at first principally used on the machines of the same name. It is an "inch pitch" chain, that is, it is so constructed as to work with teeth 1in. apart on the chain wheels; it consists of two links, an open one built up of four pieces, and a single solid block. The solid link should be of steel, not malleable iron. It is $\frac{1}{4}$in. to $\frac{3}{8}$in. wide, and nearly $\frac{3}{4}$in. long; a side or sectional view of it resembles a dumb-bell or sponge-cake "finger," and shows two holes, about $\frac{3}{16}$in. in diameter, drilled, one through the thickened part at each end. The other link is made up of two flat side pieces joined at their ends by two small spindles or rivets. The side links are about $\frac{7}{8}$in. long, and a small hole is drilled through the centre of each end. The small spindles are about $\frac{3}{16}$in. in diameter, except for about $\frac{1}{8}$in. at each end, where they are smaller. When the pieces are put together the spindles work in the holes in the solid links, and the side pieces are put on in pairs, so that the holes in them go over the small ends of the spindles, and so that the solid links are joined together lengthwise with fixed spaces between them. The ends of the spindles are riveted over to make all secure, one (or

both) of the holes in each side plate should be made hexagon, or otherwise than circular, so that when the spindle is riveted over it may spread into the angles and be prevented from twisting round. When well made this chain runs very well, but we do not recommend the very narrow sizes, as they are weak and wear quickly. If wide, the bearing surfaces on the spindles and on the teeth prevent the chain stretching as fast as it does if narrower. The best sorts are hardened. It is strong and free from spring. The two ends are joined by a bolt with a thread and nut on the end. The small end of the bolt screws into the side of the link, which is tapped to receive it, and the nut locks it in place. Great care should be taken to see that the screw is firm, as an accident is liable to result from the bolt suddenly loosening its hold. This bolt takes the place of the spindle, so this kind of chain can be removed without shifting the adjustment, but in the case of a link breaking the aid of a repairer must be sought. If the spindles do get loose and turn round in the side pieces instead of in the solid links, a fracture is merely a question of time. Otherwise breakage usually occurs at the ends of the blocks.

In the roller chain the outer links are somewhat similar to the open links of the Humber chain, but the solid link is replaced by one made in two pieces, being divided vertically lengthwise; it looks something like the open link, but it is narrow enough to fit between the sides of that, and the hollow spindle is large enough for the rivet to pass through it; moreover, the parts of the spindles of this link are in one piece with the sides. In fitting together, a loose sleeve or collar is put over the spindle, and this revolves as it bears against the teeth of the wheels, and so reduces friction to some extent, but in course of time this sleeve is apt to wear through and drop off, thus making the chain slack on the wheels. It is a very fair chain, but rather clumsy, and so are generally the wheels used for it. Its openness makes it more suitable for use without a gear case than the block variety, which is more apt to clog with mud, and burst. The links of the chain being open from end to end the teeth have to be long to fill up the space. This allows of two sets of teeth, or rather of hollows, being cut on the same wheel, as if a $\frac{1}{2}$in. pitch chain were going to be used, so that the chain can be shifted every now and then into the intermediate teeth, thus making the same wheels last considerably longer, and getting over the principal defect of the chain to some extent. If an odd number of hollows be cut the chain will not require to be shifted, but will really shift itself. The extra hollowing out also reduces the extra weight of the wheels somewhat. It is joined up like the Humber chain, though sometimes the nut is dispensed with; if so, special attention should be given to see that the bolt does not unscrew, and it is as well to burr the end over a little to help keep it in

place; otherwise our remarks regarding the Humber chain on this point, on removing, on the difficulty of repair, and on the spindles loosening, will apply to this kind also.

Chain Adjustments.—There is no chain on the market, so far as we know, in which wear is compensated for by shortening the links, though we have seen such an article. The universal, though theoretically, if not practically, less perfect arrangement, is to increase or decrease the distance between the two chain-wheels. There were two distinct ways of doing this—(1) by moving the front crank-axle chain-wheel (and with it the cranks, pedals, &c.), and (2) by moving the back chain-wheel (and with it the driving-wheel, &c.), but the first method has fortunately died out. With the second arrangement it is not possible to adjust the crank-axle parallel to the spindle of the back wheel, as it sometimes was with the first arrangement, still it does allow the back wheel to be brought in track with the front one, which we consider of much greater importance. Though some forward adjustments were undoubtedly better than some backward, the best backward is much to be preferred to the best forward.

The almost universal way is to slot the fork ends in which the rear-wheel axle rests, so that by loosening the nuts and pulling the wheel back, the chain may be tightened. But this alone is not enough, as beside being very insecure, the chain being on the side, there is a tendency for the wheel to get askew in the frame, the axle moving back further on the side opposite to the chain. Therefore some sort of screw arrangement, the simpler the better, should be fitted, and should be capable of not only drawing the wheel back, but also of pushing it forward if required. See also that it is easily got at, and does not involve a lot of screwing to get the wheel in and out of the frame.

Crank Throw and Gear.—Other considerations apart, and supposing the crank throw to remain the same and the pedals to revolve at the same rate in each case, there is no disputing that (1) the lower the gear the easier will be the work and the slower the rate of progress, and (2) the higher the gear the harder will be the work, and the faster the rate of progress. If the crank throw be lengthened, more leverage will be obtained, and the power will be used to better advantage, so that a higher gear may be used than with a shorter crank throw; but this theory only applies within certain limits, and the rider will find that he cannot work to the greatest advantage with a crank throw of more than a certain length—we are inclined to think the right length is about equal to the distance from the centre of the ankle joint to a point on the sole of the shoe, immediately under the ball of the foot, measuring on the inner side of the foot, but it may only be a personal coincidence. When the rider has found out the rate of pedalling

and the longest crank throw that suits him, he will be in a very good position to ascertain the gear which will enable him to go at the greatest pace with the least exertion. As riding on a heavy, weak machine over rough, muddy, hilly roads, and against the wind, means harder work than on a light but rigid machine over smooth, dry level roads with the wind, a lower or higher gear should be selected in proportion, as the former or latter conditions are expected to predominate.

If a slow motion of the pedals be preferred, a high gear should be chosen; if a fast motion is found more suitable, a lower gear should be ordered. Beginners and weak riders should gear low; practised or strong riders prefer, or profess to prefer, a rather high gear. But, as in the old ordinary days there was a craze for riding the highest wheel one could stretch, so, unfortunately, there is nowadays a tendency to gear too high. One may get accustomed to almost any gear, but a high gear strains the system much more severely than a low one, and should therefore be adopted with caution. More real enjoyment is to be had out of a low gear than a high one, as a rule.

A wheel should not be geared double, *e.g.*, a 28in. wheel to 56in., as the driving strain is then concentrated unfairly on one part of the wheel. In such a machine it will be observed that when the right pedal is at the point where the pressure is greatest, the top tooth on the back hub and the part of the tyre in contact with the ground will be subjected to greater strain than the other teeth and parts of the tyre at that time or at any other time during the stroke of the right foot. When the left pedal comes round to the corresponding position of greatest pressure, it will be found that the tooth on the hub and the part of the tyre that are now subjected to the maximum strain are the same as before. Thus these particular parts get the most work, and those diametrically opposite to them get the least. It is not desirable to let the strains be concentrated more often than necessary on any one part, and, to make the repetition of concentration as infrequent as possible, the driving chain-wheel should have preferably one tooth more or less than double the driven (hub) wheel, in which case the strain will be fairly distributed to each tooth on the hub and all round the tread of the tyre.

The strain, of course, in all rear-driving safeties comes on to the same teeth of the crank-axle chain wheel, and this, unfortunately, cannot very well be avoided. We do not think a rider should gear higher than he otherwise would do in order to escape this evil, but should rather gear lower, or accept the double gear, and counteract its effects by occasionally altering the relative position of the crank-axle chain wheel and hub chain-wheel by shifting the chain a link or two along the teeth of one of them. If this be done regularly

and systematically, the damage done by a double gear in a well-built machine will probably be inappreciable. To go into figures, we should say that 54in. is a low gear, 59in. a good average, and 64in. a high gear for the road; 6in. is a short crank throw, 6¼in. a good average, and 6¾in. a long throw. These may be taken as a general guide, and modified according to the circumstances and conditions enumerated above.

Many outsiders think that the power of the arms is totally wasted when riding a cycle, and that a gear to be worked by the hands might be advantageously added to the pedal gear. But the steering of the machine takes a good deal of arm power, especially at first; and more than this, roughly speaking, directly the rider applies more power than would lift his weight, he must hold himself down with his arms by pulling at the handles, so that in hill-climbing, at any rate, the arms are very fully called into play. Still the arms are used less than the legs, and we are not prepared to say that the outsiders are entirely wrong, though any motion of the arms has a great tendency to hamper the rider's breathing. If the handles be properly placed, he can apply power, when necessary, with both arms, and at least one leg, at the same time.

Speed and Power Gears.—It will very likely have occurred to the reader that an arrangement whereby he could, without altering his rate of pedalling, acquire power when riding uphill and under other adverse circumstances, or speed when riding downhill or with the wind, would be of considerable advantage. Various inventions to this end have been introduced, but owing to their additional complication, weight, and expense, and the naturally good hill-climbing qualities of the rear-driving safety bicycle, they have not been largely adopted on this style of machine; however, for very hilly districts we think they are of considerable value. If the rider invests in this extra to his machine, he should be careful to avoid getting the low (or power) gear too low, or he will find that when he puts in this gear the work will be so easy that he will rapidly exhaust himself by fast pedalling. For a rider who would choose a 57in. gear, if he confined himself to one, we would suggest a combination of about 60in. for the speed gear and 51in. for the power gear. These gears are usually actuated by a small lever fitted on the handle-bar, and it is advisable to momentarily slacken the pressure on the pedals while the change is effected. A two-speed gear is often disappointing at first, but improves on further acquaintance.

Means by which the rider can change the gear of his machine when not riding are more common, and usually consist in detaching one of the two chain-wheels and replacing it by one with more or fewer teeth on. These methods involve either adjusting the chain or even adding or detaching one or more links. It is better in one

respect to change the wheel on the hub, as this equalises to some extent the wear on hub chain-wheel and crank-axle chain-wheel, whereas if it be the crank-axle chain-wheel that is changed, the evil of unfairly-proportioned wear is exaggerated. Some machines are fitted with two chain-wheels on the hub, one having more teeth than the other, and the gear is changed by taking out the driving-wheel and reversing it, so that the other chain-wheel comes into line with the chain-wheel on the crank-axle. Beside the consequent chain adjustment, the spindle is either turned round with the wheel, and the adjusting cone has a tendency to screw in and jam the bearing, or the hub has to be reversed on it, and the balls made to run between surfaces which are not used to running opposite to one another—tending to destroy the bearings—but this objection might not amount to much in a first-class machine. These methods only cost a few shillings extra as a rule, and perhaps some of them are worth the money, though we do not think they are often taken advantage of when obtained.

GEAR COVERS.

It is a disadvantage with chain gearing that dust and mud accumulate in the working parts, increasing friction and wear, and that rain is apt to cause rust and stiffness in the joints of the chain, leading to fracture. And if trousers be worn they are very liable to be soiled and torn by the gear. Guards are therefore sometimes fitted to the chain, but as there is some difficulty in attaching them so that they will not rattle, they are not so often fitted now as formerly. The most efficient thing in this way is, no doubt, Harrison Carter's oil-tight chain lubricator and guard. It is so built and attached that dust, dirt, and rain are excluded; besides this, oil is poured into the case at the lower end until it is just high enough for a small part of the chain to run in it. The chain is thus kept quite clean, and is constantly lubricated outside and in, the result being noticeable in the gear running very smoothly and easily. But, however desirable a thing it may be to protect the working parts of the chain and chain wheels from dirt and grit, and to lubricate them efficiently, it is not an easy matter to carry it into practice. The cases, which are made of tin (tinned iron), have to be shaped to fit the machine; all joints must be proof against dust and rain from without, and against leakage of oil from within, yet there must be no friction against the revolving parts, and means must be provided for adjusting the chain and hub and bracket bearings (specially note if there is proper facility for oiling the crank-axle bearing on the chain side). Some of the very first Carter cases were made detachable, but this was given up in favour of making them fixed to the machine with an opening at the back whereby the wheel may be withdrawn. Fixed cases are much

more likely to be tight than detachable ones, but the later detachable Carters may be purchased with confidence, though, of course, a good deal depends on the individual workman. The prejudice against the gear case was nearly too strong for it, and even after it was fairly established there were signs of waning popularity.

A number of other cases or guards have been introduced, some constructed of metal, others of patent leather or japanned fabric stretched over light metal frames, and others of celluloid, papier maché, etc., but none of these have the patented bath lubrication. The slight reaction against gear cases will probably be followed by a much greater revulsion in their favour, but the leather or japanned fabric guard has advantages over its metal rival that may reasonably be weighed against bath lubrication. The reaction against gear cases was no doubt owing to chains becoming disconnected (by actual fracture or the connecting pin working out) while confined in fixed metal cases, causing terrible havoc, the chains cutting through the cases, which had, as a preliminary step towards the reinstatement of peace and order, to be cut right away, an operation of much trouble to both mind and body, especially on the public highway. When such things happened in racing it was particularly exasperating, and vows never to use such contrivances again were no doubt made with such vehemence as not to be lightly broken, though the introduction of detachable metal cases may have been a strong temptation. We believe it is exceedingly difficult to make even a fixed case of the Carter type absolutely oil-tight, and a detachable one more so, and in a large proportion of instances the difficulty is not completely overcome. The direct object of a gear case is to keep the chain clean; and this allows of an indirect advantage being obtained—the chain may be freely lubricated. Bath lubrication may be the most complete system, but it is only better in degree than other systems, and the comparative advantage of the bath must be reckoned in the balance sheet of points, for and against, along with the others. A metal case is at a disadvantage if the chain breaks; it is heavier, it is liable to make or encourage a noise, and it is expensive.

On the other hand, if a chain breaks in a "guard," it can be got at with comparatively little personal injury or inconvenience, either by undoing the fixings, or, if the worst comes to the worst, by slitting the material with a penknife. The "guard" can be repaired, if desired, at a small cost, but the "case" is generally irreparably ruined, whether detachable or not. The "guard" will sustain a knock with equanimity which would seriously damage the appearance of a "case," if not its utility. Guards are frequently fitted with lubricators that not only serve their purpose well, but allow of the supply of lubricant being cut off when not

required, as when the machine is not running. The guard is commonly much lighter than the case; it is quieter, and, point of points in popularity, it is much cheaper. But the principal question is, is the guard as good a dust protector as the case, especially the Carter case? Probably, taking the average capabilities of the rivals, the guard is inferior, though, personally, we have no cause of complaint on this head. Still, we think the perfect gear case, though walled with leather or fabric, should have adjustable metal dust slides, and the attaching and detaching fixings should also be of metal; at any rate, something better should be substituted for the present makeshift arrangements at the hub and chain adjustment, and for the fastening by lacing. A good sized transparent "window" will also be apppeciated, if only to see how much "slack" there is in the chain.

As there is often no room to spare in fitting a gear-case, the nut is sometimes removed from the connecting pin to make clearance, but this should be avoided if possible; a periodical inspection should be made to see that the joint is secure.

If the driving wheel has to be removed from a machine fitted with a fixed case it will be necessary to undo the chain. Open the back and turn the wheel until the pin is opposite the opening, but before undoing it secure the two ends of the chain by wire or string by their links next to the end links, and tie them so that they cannot fall into the case. By holding the links named, one has a better chance of manipulating the end links in reinserting the pin after the wheel is replaced.

THE PEDALS

receive the rider's pressure direct from his shoe; they should, therefore, not be too soft. On the other hand, if very hard, the vibration may be felt so much as to induce fatigue and numbness in the legs and feet. The pedal consists of a rectangular frame made up of two side plates placed opposite one other, and joined near their extremities either by two small bars clothed with rubber (pedals so fitted being called rubber pedals), or by two flat bars placed vertically, and having serrated edges, giving the pedal the name of "rat-trap," which article it somewhat resembles.

The bars carrying the rubbers should not be riveted up at the ends, but one end of each should be countersunk into the plate nearer the crank, so that the pedal may run close to the crank face, as before explained; the other ends should be screwed and fitted with nuts, so that the bars can be easily removed when new rubbers are required. It is not so important that the rat-trap plates be made detachable in this way, as they would be more liable to jar loose than when fixed by riveting. The whole pedal revolves on a pin which runs across the frame through the centres

of the side plates, midway between and parallel to the rubber-clothed or serrated bars. The back of the inner bearing cone forms a shoulder to bear against the crank. The pin is then generally turned down to about $\frac{5}{8}$in. diameter for about $\frac{3}{8}$in., and two flats are filed parallel to one another on this part to allow of the pin fitting into the slot or hole in the crank, and to prevent its turning round when in. Makers sometimes send out the pedals without first trying them to see if they will go on all right, the consequence being that the pin is often too large to go in the slot, and the rider has to pay for their being fitted if he is not handy with a file himself. In that case the maker might fairly be asked to pay for the little job. On the other hand, this part should not be a loose fit in the slot, or when the nut is tightened up on the end of the pin on the other side of the crank, the pin will turn round a little way with it, and after use for a bit may turn back again and loosen the nut. The rest of the pedal-pin is turned down to the size of the part next to it between the flats, or a trifle smaller, and a thread cut on it for the nut to work on. This nut should be large across the flats, $\frac{7}{8}$in. or so, or, if smaller, a good broad washer should be used between the nut and the crank. There are a number of other ways of fitting the pedal to the crank, the object of most being to save the thickness of the nuts in the tread of the machine, which is a good way of reducing the width, but none of them, so far as we are aware, allow for any adjustment of the crank throw. Some of the saving is sometimes lost again between the body of the pedal and the crank. Whatever the method, it should allow for ample strength and security.

The centre tube should be provided with a small oil-hole covered by a spring cap, so placed that the foot will not touch the cap, and yet so that the hole may be easily reached with the spout of the oilcan. Rubber pedals afford a better grip than rat-trap on a rough road, presuming the rider is wearing plain soled shoes, and are more comfortable, as they absorb the vibration, but they also absorb the power to some extent, and if they get wet are sometimes very slippery; the rider must then take care how he pedals, as if his foot slips when he is exerting much power he may injure himself.

Rat-trap pedals afford a better grip in wet weather, and do not absorb power, and being rather lighter than rubber they are fitted to racing machines, but they jar the feet considerably on rough roads, and the teeth soon wear blunt; while sharp they are very destructive to the soles of ordinary shoes. For road racing, many riders prefer rubber pedals. The rubbers should be square sectioned, and should turn stiffly on the bars, and so accommodate themselves to the curve of the sole of the rider's shoe. They afford a better grip than round rubbers. In selecting rubber pedals the thickness and shape of the rubbers should be noticed, as if too thin

they will not carry the foot high enough to clear the tube or pin in the centre, and if the edges be rounded off the tenacity of the grip will be diminished. The surface, too, should be smooth or nearly so, as a pimply surface wears out quickly.

The Combination pedal has two pairs of cross-bars, one set rat-trap and the other set covered with rubber, so that on one side it is a rat-trap pedal, and on the other a rubber, thus containing in itself the advantages of both kinds; it should be balanced so that one side will turn up as readily as the other. It is one of those good things which for some remote reason have never become so popular as they deserve.

The pedal should be wide enough to receive the shoes freely, but not much more, as the feet are apt to work apart from each other on wide pedals, and get into bad habits in the matter of position. Query, if a narrow tread is natural, why do the feet so work apart, or rather some feet? For ourselves, one does and the other does not.

THE SADDLE.

The saddle and spring, formerly built separately, are now always united, though some of the springs are hardly worthy of their names, being little more than rigid frames. The leather top or seat is secured to the ends of the spring at back and front. At the front there is a tension arrangement, more or less inaccessible, for taking up the slack as the leather stretches; at the back there is a cantle plate, to which the leather is riveted, and by which it is bolted to the spring.

Some day, perhaps, means will be found whereby the present spring may be dispensed with, and a rigid connection between the saddle and the frame and driving gear be afforded. Meanwhile, the saddle and spring should be the best of their kind, and, for road work at any rate, it is a great mistake to sacrifice comfort to weight, as the increased vibration arising from a hard, light saddle will prove a greater hindrance than the increased weight of a more competent spring and ample top.

Springs.—As the rider's comfort depends very largely upon the spring, he should take great care to get one suited to his weight, as if it be too pliant it will close with a jerk whenever an obstacle is passed over, and probably soon break; if too stiff, the rider might almost as well be without any. A too pliant spring may be rendered stiffer by placing rubber blocks between the parts, but this should be only a temporary makeshift until a stiffer one can be procured. We know of no remedy for a too stiff spring, except getting a more pliant one. Though the spring should be pliant vertically, it should be as free as possible from lateral movement; if it give much sideways it will prevent the rider getting a proper grip of his machine, and make riding on loose

or greasy roads very open to the danger of side-slipping. If the spring have no working parts, so much the better, as there will be less chance of its rattling, and it will require no oil. The springs are usually made of thick round wire, or rod, curved and coiled to give greater flexibility. The coils should be of fairly large diameter, or they will be liable to snap, besides being less elastic. Beside the spring proper, there should be two stretcher-rods running from the back to the front of the leather to keep it extended to a fixed distance independently of the motions of the spring.

The seat or top is as great a factor in the comfort or discomfort of the rider as the spring, but here it is rather a question of fit than weight-carrying, and it is often a good plan to retain the saddle, if comfortable, when disposing of a machine. The weight of the body should be carried on the bones provided for the purpose, and all pressure on the perineum should be most carefully avoided. In plan the seat is somewhat pear shaped, but with incurved sides. The peak should be narrow, so as not to interfere with the action of the legs, and the back should be wide to provide plenty of support in the right place. The ends of the cantle-plate should be curved down slightly; they are very uncomfortable if too prominent. The leather should be carried down a good depth at the sides of the peak; if too short the edges will chafe the legs and wear out the "breeks." The leather stretches gradually, and unless tightened up becomes uncomfortable. Especially will the leather stretch if it get wet, so when the machine is left out of doors the saddle should either be taken off or be protected by one of the waterproof covers sold for the purpose, or the machine may be turned upside down if there be no lamp on it. If no provision be made for the purpose in the saddle itself, or if its capabilities be exhausted, the leather may be tightened as follows: Cut out a strip of the leather about 2in. wide right across near the back, punch a row of large eyeholes along each edge, protect the holes with the little brass rings made for the purpose, and lace it up like a boot, with a broad flat lace. A saddler will make the holes and provide the lace for a small sum, and the rider can lace it up himself; care should be taken to avoid puckering. A saddle so treated will be found more comfortable than it was at first, if properly done, and any further sag can be taken up by tightening the lace. To avoid perineal pressure a long narrow slit is made down the middle of the leather, but unless further means are adopted to prevent it, after the leather has stretched and been tightened up once or twice, a bad ridge will form just where it is not wanted. To cure this, take a knife and make two slits about $\frac{3}{8}$in. long, and about 80° apart from the front end of the long slit in a forward direction, and press down the little tongue between them. It may be found necessary to widen the long slit by cutting out a narrow strip. If the ends of the slits show a

tendency to crack further, put a short cross slit across the very end of the slit or crack.

The natural coloured tops are to be preferred, as the coloured tops are given to parting with their dye and decorating the rider's clothing.

The tensioning arrangement provided in most saddles consists of a screw and nut fitted between the leather and the spring in front, in such a way that turning the nut pulls the leather forward, and so tightens it. The leather should not be tensioned up too tight, or it will be hard to sit upon, and the strain may tear it where it is riveted to the plate. A new saddle is sometimes very hard, but the leather may be softened by rubbing in soft soap, where it is required to give, on the under side.

The Pitch of the Saddle and Spring.—If the saddle and spring are rightly pitched, the rider will be able to sit in the saddle with his feet off the pedals, and his hands off the handles, without any tendency to fall off backwards or to slip off in front. When trying this, the machine must be held up by a second person or other steady means. The second tendency is the more common one, forcing the rider to keep pushing himself back from the handles; this is uncomfortable enough in itself, but is made worse by the vibration, which is felt much more in the arms if they are held stiff than if flexed.

It is best to have the peak a little higher than the back, so as to throw the weight on to the broad part of the saddle, and prevent slipping off forwards. The usual means for adjusting the pitch or tilt of the saddle consist in curving the parts of the spring by which the saddle is clipped to the arm of the saddle-pillar, and in forming the clip itself to match, so that when the clip is loosened the position of the spring and saddle may be set to any angle desired.

The clip for attaching the saddle to the pillar must be capable of obtaining a firm grip on the arm and on the saddle, and it must be of sufficient length to prevent the parts pitching to and fro. A fashion has arisen for making clips suitable for fitting various sized arms, and for making one screw hold the clip to the arm, and the spring in position too, but these are not at all desirable points, rather the reverse. A clip that will grip arms of various sizes may probably not grip even one securely without damaging it; and if one screw only be employed, altering the position of the saddle on the arm without upsetting the tilt, and *vice versâ*, requires care.

The pneumatic saddle depends for its elasticity on a pneumatic cushion acting as a sort of stuffing to the top, which is not usually suspended as above described. Some find this arrangement very comfortable, others complain that it causes numbness and stiffness; each must decide for himself. The pneumatic principle has been successfully applied, by introducing an air cushion in place of the ordinary springs under the back of the saddle by Mr. Lycett, of Birmingham.

THE BRAKE.

As this part of the machine is used only in the event of a greater or less emergency, there should be no doubt of its efficiency. It should be capable of easy and immediate application, and of effect varying from very slight to very powerful. It should not interfere with the action of the rider or the proper working of any part of the machine. It should also be simple, light, certain, and not liable to get out of order. Unfortunately, neither the "spoon" nor the "band" (the two kinds of brake in use) is absolutely reliable under all conditions. The spoon brake acts on the tyre of the front wheel, seldom the back; the band brake acts on a drum attached to the hub of the back or front wheel, and occasionally the crank-axle.

Some prefer the brake to act on the front wheel and others on the back. The brake on the crank-axle acts on the back wheel through the chain. The advantages and disadvantages of the two kinds may be summarised as follows:

Brake on the Front Wheel.

Advantages.

The retarding power can be distributed over the machine, as the rider can check the back wheel by back-pedalling with his feet while holding the front wheel with the brake.

The steeper the hill the more the rider's weight is thrown on to the front wheel, especially if he put his feet on the rests.

The connections are shorter than those for the back wheel, and so are more rigid and lighter.

Disadvantages.

If put on suddenly on a loose or greasy road, or when running out of a straight line, the back wheel with the rider may swing round sideways and a fall result.

The weight of the rider and the back of the machine put a heavy strain on the crown and front of the machine.

Brake on the Back Wheel.

Advantages.

The drag being behind, there is no tendency to swing round.

No extra strain is thrown on the front part of the machine.

The rider can, if necessary, brake the front wheel with the sole of the foot, thus checking both wheels.

Disadvantages.

Back-pedalling is of little additional advantage.

The connections are longer, heavier, less rigid, and usually more complicated; if simple, they throw a great strain on the handle-bar stem of the machine.

The back wheel has quite enough work to do without the severe strain of the brake on it.

The *pros* and *cons.* of spoon and band brakes are as follows:

SPOON BRAKE.

Advantages.	*Disadvantages.*
Is not liable to fire.	Its efficiency is greatly detracted from by wet or snow.
It only retards the machine when put on by the rider.	Is often liable to damage the tyre.
If on the front wheel, the connections are short and rigid, and few in number.	

BAND BRAKE.

Advantages.	*Disadvantages.*
Is not affected by wet or snow.	Is practically always "on" to some extent.
Is perhaps more powerful than the spoon.	Is useless if any oil gets on the drum.
	May "fire" when in use, and so lose its power at a critical moment.
	If on back wheel the connections are specially long, heavy, springy, and complex.

For all practical purposes we have found a "direct plunger spoon brake" on the front wheel answer very well. It is formed with a horizontal lever working vertically on the handle-bar; the fulcrum should be about 4in. from the centre of the handle-bar, and the lever should finish up in a good-sized handle, coming well out to the end of the handle-bar, and formed in one piece with the rest of the lever. An additional lever fitted to the left handle will enable the rider to change and so rest his hands down a long hill, or to apply extra force by using both hands at once. The spoon should be convex on the under or wearing side, so as not to damage the tyre, and it may be covered with rubber or leather as a further precaution, and to increase the effect, especially on wet roads. A tube not less than $\frac{3}{8}$in. dia., 16g., should be brazed to a lug on the top of the spoon. This lug should be in the middle, as if it be at the back it will throw a great bending strain on the tube, etc., when power is applied to the brake, beside adding to the liability of the spoon to dig into the tyre.

A solid rod should work telescopically in the upper end of the tube, being fixed in position by a set-screw or grip. The top end of this rod should be jointed to the short end of the lever securely, and in such a way as to avoid rattle.

The brake tube should pass through a guide attached to the fork crown, close down to the spoon, so as not to place more strain on the lower part of the tube, when the brake is on, than necessary.

At the same time the spoon should be allowed to rise ¼in. or more away from the tyre when "off," or mud will be liable to lodge and put on an uninvited brake.

The back part of the spoon should lie under the fork crown, so that much of the dust and mud cleared off when the spoon is pressing on the tyre may fall straight down, instead of being scattered over the rider's legs when his feet are on the rests.

Sometimes the spoon is linked to the fork crown by a shackle resembling a link out of a roller chain. This is probably done to save the rattle that may occur between the tube and the guide above mentioned, owing to the lower part of the tube being reduced in cleaning up after brazing on the spoon, but the links are apt to wear, and cause rattle themselves.

A spring is required to hold the brake off and prevent rattling. One of the best for the direct plunger is a coil spring round the lower part of the brake tube bearing on the guide below, and a split pin or other projection on the tube above. The spring should be strong enough to answer its purpose without materially adding to the difficulty of holding the brake on. Or a spring may be fitted between the long end of the lever and the handle-bar.

If the spoon-brake be applied to the back wheel, it should be so placed that it does not throw the mud on to the chain, nor into the crank-axle bearings. The spoon should, therefore, be below the crank-axle.

Better than this is the band-brake on the back wheel. A drum, which should measure quite 4in. in diameter and ¾in. in breadth, is formed on the hub of the wheel. Round this is placed a flexible steel strap lined with leather; one end is attached to the frame of the machine, and the other, by various connecting rods and bell crank levers, to the lever on the handle-bar; these small levers require to be nicely planned, and the adjustment of the connections so arranged that when the brake is "off" the band shall not touch the drum, and when it is "on" it shall grip the drum without the handle of the lever touching the handle-bar. Adjusting the chain should not interfere with the adjustments of the brake. There was some attempt a little while back to push this brake on the market, but it has not come to much. It does not appear to be worth the extra weight, trouble, and expense. Similar remarks apply to

The band-brake on the crank-axle, which has the additional defect of working through the chain instead of direct.

The band-brake on the front wheel is sometimes fitted. It has some advantages, but great additional strain is thrown on the fork and crown, which are ill-calculated to bear it.

The brake band should be long enough to almost encircle the drum, and of equal thickness throughout, so that it may get as

much grip as possible, and not merely press against the drum in one short part, or at two or three points. Some people saturate the leather with olive oil to help it lap better, but unless very well done this is much worse than useless. The copper rivets should be well sunk, so as not to touch the drum. The brake drum is sometimes turned with grooves in order to increase the grip; it should be rigidly secured to the hub at a safe distance from the spokes and frame. Brakes are often made so that they can be taken clean off the machine without leaving any traces. This is a neat idea, but see that security is not sacrificed to neatness. There should be no necessity to remove the front wheel, or to undo the joint, or the adjustment on the rod, in order to detach the brake. The guide on the fork crown can be button-holed and provided with a loose fitting piece, and the lamp-bracket can be forked for this purpose. The pneumatic principle seems likely to be applied to brakes with some success.

THE STEP

is used in mounting and dismounting from the machine, and so must be strong enough to sustain the entire weight of the heaviest rider the machine is likely to carry. It is fitted on the left side near the axle, and is roughed or serrated to prevent the foot slipping off it. Sometimes it is a round plate supported on the top of the shorter side of a J-shaped bar, the upper end being attached to the machine; this is unnecessarily heavy, and from its shape apt to bend. The step should not be under the nut of the rear spindle or any other projection, else the rider may put his foot on to it instead of on to the step, and, slipping off, get a nasty graze or even fall. About the simplest and best arrangement is to produce the axle nut a couple of inches and roughen the exterior. If the mudguard stays do not fit on to the axle, it (the axle) may be extended, leaving it full size to carry the thread at the nut, and then tapering it off and serrating it, to give it a neat appearance and firm grip; but this is not a convenient arrangement with mudguards as ordinarily constructed, as it is often difficult to get the stay eye to pass off the end of the step. The step should be rounded off at the end so as not to damage anything it may come into contact with.

THE FOOTRESTS

are generally fitted towards the top of the front fork. They are usually pressed out of thin metal plates with serrated edges, and are clipped on with bolts and nuts. They should be so fitted as to not weaken the forksides, and yet be secure from slipping down—a broken forkside or treacherous footrest might result in a serious accident. The use of footrests, or rather flying hills feet

up, puts a rough strain on the fork, and so the practice is discouraged on some light machines by fitting no rests, but for all-round use it is better to have the rests and the fork strong enough to carry them. The top of the fork crown can be used to put the feet on if there are no rests.

THE MUDGUARDS

are fitted to the front and back wheel to prevent the mud being thrown on to the rider. They are made from sheet steel rolled to a nearly semi-circular section, and are curved lengthwise so as to be parallel to the tyre of the wheel. Sometimes they are corrugated; this increases stiffness, and allows lighter metal to be used, but it is difficult to clean the mud out of the corrugations if too small. If the edges are beaded it stiffens the guard and avoids a risk of cutting the fingers. They are usually fixed to the machine at one end, and supported at the other by a pair of struts. The guards should be fixed so as to leave a good inch of space between them and the tyre; even then mud, when of a certain consistency, will manage to lodge inside and clog, but this is not often the case. The parts of the struts secured to the guards or the fittings on the guards into which they screw should be put on the outside of the guard, at least in the case of the front one, so that no ledge may be formed for the mud to accumulate on. Where the guard is fixed to the framework by screws, it should either be strengthened by a lining some 4in. or 6in. long, or there should be a stout leather washer between the guard and the frame, otherwise the vibration will likely very soon snap the guard; perhaps the leather is better, as being somewhat springy it acts as a cushion, checking the vibration, and helping the screws to maintain their grip. The struts should be stiff with an eye or ring at one end, of such a size as to fit over the spindle between the fork-end and the nut. The eyes should be perfectly flat, or they will throw the nuts out of truth and strip the screw threads. The struts should be threaded at the other end to screw into the fitting brazed to the guard; this is a better method than having the two struts all in one piece, flattened out in the middle, and riveted to the guard, as it allows the struts to be adjusted and the guard set nearer to or further from the tyre, or sideways if desired, and they can be taken right out of the guard when the latter is detached from the machine, so taking up less space, and being less liable to damage than if fixed. Round struts look much neater than the wide flat ones sometimes used; in either case for appearance sake they should radiate from the centre of the wheel, and not from some point out of the centre; on the other hand, if the ends be fixed to the frame instead of put round the spindle, there is

generally no need to interfere with them when taking the wheel out, which is an advantage, nor to touch the nuts when taking the guards off. If the chain be adjusted by moving the back wheel, the fittings must allow the back of the guard to move with the wheel, otherwise, if the chain stretch much, the wheel may come in contact with the guard at the back, or, at least, mud may clog in the diminished space. The rear guard should be secured to the frame by screws, and should be just so long at the back that if the machine be pushed backwards against a wall or other upright the wheel will touch, but not the guard; in front it should come so far down as to keep the dust and mud from flying off the wheel into the crank-axle bearings. The front guard may be attached to the fork crown by a strong hinge, so placed that the bolt may be taken out and the guard detached without removing the wheel; the lower end should clear the ground by 4in. or 5in., so as not to catch when wheeled off an ordinary step or curb, or ridden over a brick. This will hardly be long enough to protect the foot at the bottom of the stroke, especially in slushy weather, so a piece of stout leather (if finished with the "patent" process on the outside, it will match the enamel better) should be attached to the end of the guard; it should be the same width as the guard where attached to it, and widen off to about 6in. at the lower end, which should come within an inch of the ground, or even less. Being flexible it will not hurt if it catch against an obstacle.

It is generally considered wise to save the weight of the guards when the machine is to be used for racing purposes, but for long races on the road, at any rate, it is better to keep the front one on, as a shower of rain will soon make the roads muddy, and the crank-axle and pedal bearings are liable to choke with grit and mud thrown from the front tyre if unprotected.

If the nuts on the spindles of the wheels have to be moved in order to get the guards off care should be taken to see that the wheels are true in the forks and the bearings at the right adjustment when tightening up again. The guards should be so fitted as to protect the crank-axle bearings from the mud thrown by the wheels both front and back.

The guards may slightly slow the machine by offering resistance to the wind like sails, and it has also been contended that the air becomes compressed between the tyre and the guard, and acts as a brake, but we do not think there is much in this notion, especially as the wheels are not furnished with paddles.

Riding on muddy roads without guards, so that the dirt is transferred to the face and hair, as well as the clothes of the rider, cannot be considered other than a filthy practice, and the sight of a mud-bespattered, not to say smothered, wheelman is not calculated to promote the interests of cycling among decent-minded people.

It would be difficult to devise anything much simpler to detach or much lighter than the steel guards fitted to the modern first-class safety, and yet there are a host of detachable contrivances sold. Few, if any, of these are to be recommended. No front guard that does not move sideways with the steering wheel can be much protection to the feet, and the back guards seldom reach back far enough. Thin boards, strips of cardboard or oilcloth, or straw bottle envelopes, can be rigged up as temporary protectors if really necessary, but they are not elevating.

Nuts and Bolts.—The less of these the better, as there will be fewer points to go wrong. At the same time, there should be enough to provide efficient adjustment, and, as a general rule, it is not desirable that one bolt or nut should lock more than one adjustment, for reasons already stated. Further, the fewer different sizes of bolt heads and nuts the better, as not so many holes are required in the spanner, which can thus be made smaller. Again, the fewer the different screw threads the better, as in case of accident or loss, and no duplicate being handy, it may be possible to take a similar bolt or nut from some less important part of the machine to repair the deficiency. A committee was once appointed to try to get the manufacturers to adopt certain standard nuts and bolts. The object was excellent, as it is obvious that if it were attained it would be much easier to get duplicates when required, as the repairer would be willing to stock a few bolts and nuts, which would be in frequent demand, whereas at present to stock the bolts and nuts of, say, a dozen of the principal makers would mean considerable outlay, and the risk of not selling would be very great. But the committee was not successful, partly because, probably, the popular standard screws, Whitworths, are not sufficiently numerous in the number of threads to the inch to withstand the vibration and meet the other requirements of cycle construction, but principally because the variations in the machines of the different makers necessarily required differences in the bolts and nuts used in them. We think the only points in which the idea is ever likely to be carried out are in the measurements of the nuts between the flats, so that a spanner with, say, three holes would fit all the nuts on almost all machines, and in the connections for valves and inflators. Generally speaking, the nut or bolt head should equal the diameter of the bolt in thickness, and should be twice as wide across the angles as it is thick. All nuts and bolts should be of good steel —cheap machines are generally fitted with wretched nuts and bolts.

The nuts and heads of all bolts requiring to be turned should be so placed as to be readily accessible. Provision should be made to prevent the bolt turning round when the nut is being operated on; this allows of making very neat rounded heads to the bolts.

Spring Frames, etc.—An ideal spring frame would absolutely insulate the rider from vibration without causing any variation in the relative positions of the saddle, crank-axle, and handles; it would be no heavier than a rigid frame, have no additional joints (to wear, rattle, and require adjustment and oiling), and be neat in appearance, and free from minor faults. No spring frame that we know of is perfect in all these points, some being better in one respect, and others in another. In any case it should be remembered that a spring is less liable to snap if it be compressed in action than if tensioned. The mechanism should be so arranged that in the event of the spring breaking, the machine would still be rideable. Many spring frames rise or fall, or "gallop," in a manner very disconcerting to the pedaller.

Spring Forks.—These being fitted to the front wheel cut off the vibration principally from the hands, and in a less degree from the body of the rider. Whatever the arrangement, it should first allow of a backward and upward movement, as the wheel is first checked in its onward course, and then has to rise over the obstacle; and second, be rigid sideways, or the wheel will rub against the fork when turning corners, so putting on a kind of brake and damaging the fork, and also detracting from the steadiness of the steering; and third, the brake should be fitted to the rear wheel, or, at least, so arranged that the anti-vibration arrangement does not interfere with its proper working if fitted to the front wheel. This point should not be neglected.

A common method is to make a hinge in each side of the fork some few inches from the spindle, and the hinges being in line act like one. A spring is fixed on each side so as to keep the parts of the fork in line while the machine is not being ridden, but when the machine is being ridden the springs allow the hinges to give to the inequalities of the road, and so intercept the vibration. But as the centres of the hinges are above the centres of the wheel, the motion is upward and forward instead of upward and backward as it should be. This objection is absent in a variation of the above. In this case the forks are in one piece, as usual, but, instead of the hub spindle being attached direct to them, it is attached to two short arms, which run back two or three inches horizontally, and are then hinged to the fork ends. The movement of the arms is controlled by springs. The hinges of these arrangements require to be very well fitted and kept pretty tight, or the wheel will be very liable to scrape against the forks at the top. Of course, plenty of clearance is required under the fork crown, as if the wheel bumped up against the top it would be suddenly stopped, and both machine and rider would probably suffer severely.

Another method consists in making the head tube telescopic instead of being in one piece; a guide is fitted to prevent their

revolving relatively to one another, and a spring, fitted in the telescope or to the guide, controls the telescopic action and absorbs the vibration. An adjusting screw is sometimes fitted to enable the spring to be relaxed or stiffened, according to the weight of the rider. This arrangement gives upwards and backwards. Few such arrangements are now in use, but there may be room for a really good continuance.

ACCESSORIES.

Bells.—Bells are used to give notice of the cyclist's movements, and are therefore most required, like brakes, in cases of emergency; they should, therefore, be instantly available, loud, and not liable to get out of order. In crowded thoroughfares it is sometimes advisable to have a bell ringing continuously; at other times, a single sharp stroke will have more effect. Too cheap a bell is generally a bad investment; being small, it makes little noise, and the parts being badly fitted together it is soon shaken to pieces. The dome is made either of cast bell-metal or stamped steel; the latter is less liable to crack in case the bell drops, and the former holds its coat of nickel better. It should be tightly secured to its support by a good nut working on a proper thread. Before buying, take it to pieces to see that these parts are right; examine, too, the means provided for attaching the bell to the handle-bar. If it be a claw and screw arrangement, see that it is large enough to grip the tube, otherwise the tighter the screw is turned the more chance there will be of the bell working off; the screws should fit well in the holes, and two are better than one, but the best arrangement, in our opinion, is Harrison's band clip. This consists of a small flexible metal band riveted to the body of the bell at one end and passed round the handle-bar; the other end is attached to a screw, which passes through a hole in the body of the bell, and is tightened by a nut. This grips the bell firmly to the tube, and does not damage the nickel, especially if a strip of kid is put between the two. The ringing mechanism sometimes consists of a striker held just away from the edge of the dome by a spring, until a handle which is provided is depressed and released, when it taps the dome and causes one ring; this is the simplest arrangement, and we are inclined to think the best. There are several ingenious contrivances causing a series of rings at each action of the handle, but they are more liable to get out of order, and are more expensive. There are a number of simple attachments which, at the will of the rider (expressed by moving a small catch on the bell), set up a continuous jingling, or are silent; those which do not depend on a spring are better than those which do, as the latter are apt to break. The jingling is caused by the vibration shaking the weight against the dome. The bell should be placed

on the left handle-bar, about three inches away from the handle, so as to be actuated by the forefinger of the left hand. This will be far enough away to prevent the edge of the dome grazing the knuckles, yet so near as to allow the bell to be sounded without losing the grip of the handle. If the bell be provided with a continuous ringing attachment, it should be canted so that the striker almost touches the dome when on.

We have found bells practically useless in the South of Ireland, except for making the cattle get out of the way. We understand they are equally ineffective in France, where that abomination, the cycle-horn, is used almost exclusively. In crowded thoroughfares it is a good idea to have two bells of different tones, as they sound as if a body of riders were coming instead of "nobody."

Whistles.—Whistles are useful for notifying one's approach in the country, but they are not much good in towns—indeed, where trams run they are inconvenient, as if used, drivers travelling along the track will turn off under the impression that a tram is coming, and so get in the whistler's way.

Whether you use a bell, a whistle, or your voice as a warning signal, use it as inoffensively as you can. Many pedestrians are dreadfully touchy—perhaps they are jealous of the cyclist's easy and swift motion. If a person whom you are about to overtake does not take any notice of the warning—which he should hear, if not deaf—pass him carefully and at a distance, and don't ring him up just as you pass; but there is no satisfying this sort of people.

Brake-holders.—These are intended to hold the brake on at a certain pressure mechanically, so relieving the hand from a task which becomes very trying on long steep hills. They should be simple, secure, and strong, and applicable without moving the hand from the steering-handle. We do not advise anyone to put too much faith in them by setting them so that they alone keep the machine in check; a margin should be left which may be covered by back-pedalling, otherwise a lump in the tyre, or a sticky patch of road, may cause a sudden stoppage and awkward accident. They are very useful when walking down hills that are too steep to ride. If the brake-holder will admit of being locked in position when the brake is on it will assist in preventing the machine being stolen.

Oilcans, as used by cyclists, are generally about the size and shape of a watch, with a longish spout. The little screw cap should be provided with a strong pin; it runs down the spout and keeps that channel clear. When using the can, the pin can be stuck into the clothes, preventing the loss of the cap, and it is useful for clearing the lubricator holes. If the cap be lost a large pin may be substituted; it should be bent a little, so that the spring on it prevents it shaking out of the spout. The oilcans made of transparent celluloid show at once how much lubricant they contain, which is especially convenient when filling.

Oil.—Paraffin is the best oil for cleaning, sperm or neatsfoot, drawn off clear, for lubricating, therefore six to ten parts of sperm to one of paraffin make a capital oil for the bearings, etc.; it also burns very well in the lamp.

On no account use paraffin alone for the lamp, as it will burn it to pieces, and perhaps blow up.

Colza forms a good oil for lighting purposes; it is cheap, and can be obtained almost everywhere, which is a distinct advantage, as it does not do to mix oils. A lump of camphor (as large as a walnut to a quart of oil) should be powdered up and put in the lighting oil or in the well of the lamp. It prevents smoking, and improves the brilliancy of the light.

Many of the oils specially prepared are good, but one seems to have to pay somewhat heavily—for the bottles or tins perhaps.

Fill the lamp well about three-quarter full, and wipe the outside dry.

Oil Flasks.—Never carry a glass bottle or anything else of that material in your tool bag. If you are going to tour in some outlandish country (*e.g.*, France, so far as lubricating oil is concerned), take a full *tin* flask with you.

Wick.—This should fit the holder easily, should not be very closely woven, and should reach to the bottom of the well, and, say, two inches over. It improves the light to soak the wick in vinegar, but it must be thoroughly dried before putting in (in fact, all wick should be dried before using). A small piece of suitable wick is sometimes sold with each lamp. If a wick be too tight, one or more of the side threads should be drawn out.

Avoid cutting the wick; after putting in a new one, light the lamp for a little while, then extinguish it, and pinch off the charred top with a cloth, and pat it down so that it is level and smooth right across; touch it with a little paraffin, and it will light easily and give a bright light into the bargain. The lamp handsomely repays a little careful attention.

The old oil and wick should both be renewed if the lamp has been laid by for any considerable time.

The Lamp.—The requirements of the lamp are—(1) That it should give a good light; (2) that it should light easily; (3) that it should keep alight; (4) that it should be strong; (5) silent; (6) of little weight.

In order to give a good light, so far as the construction of the lamp is concerned, it should be made for a good sized wick, $\frac{7}{8}$in. or 1in., the reflectors and glass of good size, and well placed. The present "holophote" principle, borrowed from the lighthouse, is excellent. The ventilating arrangements should be sufficient without allowing the flame to be disturbed by the wind. But the quality of the light depends very largely upon the oil used and the

cleanliness of the lamp. To light easily, especially in a wind, one of the side lights should be made to slide up, and a rough surface provided just inside, so that the match may be struck and guarded from the breeze inside the lamp.

A lamp will go out if the oil is all used up, if the wick is defective, drops down in the holder, or does not reach the oil, if the road is sufficiently uneven to shake it out, or the wind strong enough to blow it out. The lamp should be set perfectly upright; sometimes a steep hill will put the light out by its tilting the lamp. The winders in all good lamps are now fitted with a spring, so that the wick cannot shake down.

All lamps to be used on safety bicycles should be provided, either in the lamp-bracket or holder, or the lamp itself, with some arrangement for counteracting the vibration set up by the unevenness of the road. The most usual method is similar to a parallel ruler, with a diagonal or other spring fitted so as to keep it open, the lamp itself corresponding to one "straight," and the part which fits on to the bracket to the other. The lamp may be carried on to an extension of the front axle, or the foot-rest, or on a bracket in front of the head. Lamps suitable for the first two positions are called hub lamps, and those for the last head lamps, the names being derived from the positions they were made for on the high bicycle. Some lamps are specially made for carrying on the footrest, but, as a rule, the anti-vibrating arrangements are not so good on hub lamps as on the other variety, and they get very dirty from the mud or grit which flies from the front wheel.

If the lamp be carried on an extension of the front axle, the extension consists of a tube about 3in. long; one end is formed like a nut, and it takes the place of the nut on that end of the axle of which it forms the extension; the other end is belled out to prevent the lamp slipping off. One advantage of carrying the lamp on the axle end or footrest is that, if it has projecting side glasses, it shows a light behind, which might be all-important in the risk or the fact of a rider being run down from the rear.

The nearer the ground the lamp is carried the longer shadow it throws, and so shows the obstacles more distinctly, but it should not hang so low as to be in the way if the machine be leant against a curb. When a bracket on the head is used, and also a front wheel brake, the tube of the latter generally passes through a hole in the former; this hole should either fit so well as to support the tube, or should be so large that the tube will not rattle with the vibration; perhaps the second method is better, as there is some risk of jamming if the tube fit tight in the hole. Wherever the lamp is carried, care should be taken to see that it is on firmly, or it will very likely jump off and commit suicide. The attachments are generally made adjustable, but if the adjustment is not sufficient

either the holder must be packed with paper or leather, etc., or, on the other hand, the bracket must be reduced. In the case of a head lamp, a small hole may be drilled through the tongue of the bracket near the top, and a split pin inserted after the lamp has been put on. Some of the spring brackets are handy in that they will fit lamp sockets of any size.

The reflectors in all good lamps are detachable, either by unscrewing, or sliding out sideways at the back, or simply by lifting out forwards in front. They should be kept bright, and may be polished with whitening, and the other bright parts may be cleaned in the same way.

The reservoir, also detachable, usually slides in two little guides at the bottom. Take care to get both sides into these guides when replacing.

The parts of a lamp should be riveted together, as, if only soldered, excessive heat may cause the members to dissolve partnership.

Even with a side shutter it is often a difficult matter to light a lamp in a wind. It is best to make sure that the lamp is in good lighting order before starting. Flaming lights are better than ordinary matches. Many vestas are too short. There is a useful little lamp-lighting instrument, about the length of an ordinary wooden match, and somewhat resembling a "pop gun." A match is inserted in a groove, and the point of the apparatus passed through the shutter; the pistol is then fired, and the match lights inside the lamp close to the wick. We have seen a similar arrangement combined with a match box, and this strikes us as an improvement. The vestas require to be of the right size and hardness, or they will either miss fire or jam. If wax vestas be used, one or two may be placed across the wick and fired with a third, the door being promptly closed. The easiest way is to light the lamp in a house or other shelter.

Cyclometers, also known as logs and distance measurers, are clockwork instruments which, on being fastened to a suitable revolving part of the machine, indicate the number of revolutions, or, better still, the exact distance travelled. They should be simple in construction, easily read, capable of being set to zero, and, above all, reliable. Most of them are made to fit on to the front or back hub; see that the instrument selected is not too large to go on. Some have the advantage of being adjustable to various-sized wheels, and this is a very considerable advantage, as wheels are often not exactly the size they profess to be; again, the rider may change his machine for another with a different-sized wheel. The instrument either revolves with the axle or wheel, when its mechanism is actuated by a falling weight, or a collar fitted round the axle or hub-centre, having a screw thread round it,

engages with the works inside the body of the instrument, which in this case hangs motionless instead of revolving. This second arrangement is certainly better theoretically, as the weight is much more likely to be influenced by centrifugal force than the heavier body. A cyclometer has recently been introduced that receives its motion from the tyre of the front wheel, and is thus a mere distance-measurer, quite unaffected by the size of the wheel and gearing of the machine. We are certainly very favourably struck by it.

Steering Locks.—As the handles are a good way behind the steering line, any attempt to support the machine by resting one of the handles against a wall is very likely to fail, as the action moves the steering wheel and, allowing the weight of the frame to heel over, lets the machine drop. If the steering be locked this cannot happen, and the machine will rest all right except on an incline. The parts of the locking apparatus are generally built in with the machine, so that it may also hinder theft. As a sudden twist to a locked machine may do damage, it is perhaps better not to have an absolute lock, but only to make the steering so stiff that the machine may be supported without fear of its falling. As a machine cannot be ridden with the steering locked, there should be no chance for the catch to jump into action accidentally. If your lock is on the permutation principle, take precautions against forgetting the letters or numbers. A locked machine is not easy even to wheel, and forcible measures may lead to undignified proceedings being taken by the local legal luminary—"Robert."

Tool-bag (Wallet, Valise, or Pouch).—The danger of carrying spanners and other implements in the pockets when cycling is obvious; in a fall they would be very liable to damage their owner. Nor should the oilcan be carried in this way, as the top is pretty sure to work off and allow the child-like and bland liquid to soil the clothes, and by its odour spoil the rider's appetite. The tools should be carried in a specially-constructed leather bag. We prefer patent leather, as it keeps its appearance better than other kinds. There should be plenty of room and several divisions, that for the oilcan being in front, where it can be easily got at. If there is not a separate niche for each article, they can be wrapt in the rags, to prevent rattling. The fastening should not be a strap and buckle, but a swivel catch, which can be secured by a padlock when advisable. The straps for attaching the bag to the machine should be riveted on instead of sewn, and if the bag is wanted to be easily removable spring hooks may be substituted for the straps. The bag may usually be prevented from swinging about by a strap fitted to the back or bottom and attached to some part of the machine. There is room for a great deal of improvement in tool-bags. Being supported from the back, they are ever on the look out for a

chance of ejecting their contents. The fastenings, too, are generally of a most trumpery character. There should be a splendid sale for a really efficient, moderately priced article.

Luggage Carriers have already been referred to in dealing with the subject of touring.

Wrenches.—An adjustable wrench should be long enough to get sufficient leverage, and short enough to go into the tool-bag. Very cheap wrenches are worse than useless; they are generally soft, and the jaws open and slip round the nut, rounding its edges and making it more difficult to turn each time. The screw being badly fitted is apt to stick. The best wrenches are made of steel, and the jaws hardened; the corners at the root of the jaws should be left in, so that they will not be so liable to snap off as if cut square. Wrenches with serrated jaws are death to the nuts. As it is often handier to put the wrench on to the nut vertically instead of horizontally, the fronts of the jaws should always be at right angles to the dividing line. Sometimes jaws are notched, so as to hold four sides of a hexagon nut—this gives a capital grip. To tighten a (right) pedal nut put the foot on the pedal and pull the wrench up with the right hand. The right pedal should be half down the stroke, and the wrench should be in line with the crank. When using very large wrenches do not use too much power.

Spoke Grips are miniature screw vices with the jaws specially shaped to get a grip on small round wire. Cheap ones may be got for 1/- or 1/3, but they are frequently defective, and it is best to spend a few pence extra and get one made of properly tempered steel.

Stands.—There are several different kinds of stands for supporting rear-driving safeties when not in use. Starley's stand is a cast-iron frame with a skeleton groove in it, which holds the rim in three places. It is best to use one for each wheel, and when purchasing any pattern it should be seen that the grooves fit the rims pretty well, as, if too tight, it is awkward to get the machine off the stands, and if too loose the machine will lean sideways and throw an undue strain on the rim where it is held. The most convenient stands hold the machine so that one or both wheels may be raised from the ground. Means should be provided to prevent the front wheel flopping round.

Home Trainers are instruments which provide pedalling exercise when actual riding is not desired or available. The best are provided with large dials and indicators, so that it is possible to race with them. They are useful in their way.

Toe Clips.—If the pedals do not afford sufficient hold a pair of toe clips may be procured and attached to them. If properly adjusted to fit the foot they are more comfortable than slotted shoes, as they allow a certain amount of variety in position, and enable the pedal to be lifted through the back part of the

stroke from 7 to 1, but are of no use from 5 to 7 (see pedalling diagram, page 34). Toe clips are not altogether desirable adjuncts. They should not be fitted close back to the toes, or they will encourage a digging action and upset the ankling. They may be set a little clear of the foot, and used only to prevent its slipping off forward, but if the rider pedals properly he will find that the tendency is for the foot to slip the other way, and toe clips are no preventive in this direction.

Trouser Clips.—There are quite a number of different arrangements for holding the trousers away from the gear when the cyclist has to ride in them. The ruling price is 6d., and some of the clips are small enough to go into the waistcoat pocket. It does not improve the cyclist's appearance to ride with his unmentionables folded tightly about his legs, but, on the other hand, it does not improve the trousers' appearance to get them blackened with oil or torn on the crank cotters. With some of the trouser fasteners it is possible to put them on so that they are not visible, and these are obviously to be preferred. If no fasteners be available, safety pins may be used, though we do not care about having to do with more sharp points than necessary.

MAPS AND ROAD BOOKS.

The Cyclists' Touring Club has in preparation a road book which should completely eclipse everything else of the kind. The first volume relating to the South of England is the only part published at the time of writing. "The Cyclist's Route Book" (Iliffe and Son, 3, St. Bride Street, E.C.) is one of the best route books yet issued. It is comprehensive, can be carried in the pocket, and a complete index is provided to make the planning of cross routes easy. Section maps are included in the book, so that the roads in any particular district can easily be followed out, and each road on the map has a number corresponding with the route. Many other books and maps of interest to cyclists are published by Iliffe and Son.

One of the cheapest things in maps we know of is "The Tourist's Route Map of England and Wales." (Upcot Gill, 1s.) It is of large size, and is mounted on cloth. As the map comprises a good bit of Scotland as well as England and Wales, the small scale, fifteen miles to the inch, must not be too severely criticised. Thirty routes, starting from London, are coloured in red, and most of the main roads and many of the bye-roads are shown by double and single lines respectively. The distances between the towns are marked. It is extremely useful in planning out tours.

Phillips (Fleet Street) and Letts publish excellent county and other maps for cyclists. W. H. Smith & Sons' sectional maps are good, and their "Environs of London," one inch to the mile (1s., or 2s. mounted on cloth), is excellent; while for the streets of

London we know nothing to equal the District Railway Map, four inches to the mile. The majority of maps are exceedingly faulty; the Government ordnance are the best.

Maps intended to be used on the road should certainly be mounted, cut into handy sized sections, and carried where they can be easily got at. A paper map open in a wind is—well, extremely trying.

Map Measurer.—This useful little article consists of a small milled wheel on a screw. It is used as follows: Run the wheel up to one end of the screw, then move it along the road on the map which you wish to measure, taking care that the wheel always runs one way. When the whole route has been traversed, reverse the instrument along the scale of miles on the map until the wheel returns to the end from which it started, counting the number of miles as it goes along. Look at the scale carefully, as some are marked 1, 0, 1, 2, 3, and so on, the first mile being divided up. There is no reason for this confusing arrangement, but, like many other similar things, it is "professional, you know." Too much pressure should not be put on it in using, or the wheel will soon get loose on the thread

CHAPTER VII.

PURCHASING.

THE price of a good cycle may seem high, but the cost of working a cycle business is very heavy, and each year the purchaser gets more for his money—improvements are made without any addition to the price of the machine. We do not think the prices of the best machines will be materially reduced—at present at any rate. Cycle making is not always the profitable business many suppose it to be.

Beware of machines off which the agent or maker offers you very high discounts, for this simple reason: The agent, in many cases, pushes the machine which pays him best; if he offers you an undue discount you may be sure he gets a very large one himself. Good material and workmanship cost money, and manufacturers are not philanthropic enough to go without their profit, therefore you may be sure if there is too big a discount there is something wrong somewhere, probably inside, and very likely many small conveniences will be absent as well.

A cheap and badly-got-up price list is generally a sign of the rest of the business being cheap, and nasty too. The most will be made of any good points, and "no news" is here often "bad news."

Testimonials should be taken *cum grano*. They should be dated, and the dates not too old; those given on receipt of machine are practically valueless—all machines nearly give pleasure at first sight. On the other hand, blanks in testimonials do not always mean that the writer has said something unpleasant; it may be a case of selecting tit-bits from the "thousands received every day." Those from riders who are engineers also are the best.

Avoid very cheap machines (with all the latest improvements). The lower the price the plainer the machine should be.

Stick to the standard pattern. A slight alteration in one part may upset the whole design of the machine and convert it from good to bad. Besides this, you may calculate on indefinite delay if you want anything out of the usual course. Machines are made in quantities, not singly.

If there be an order form in the catalogue fill it up, being careful as to points where a choice is allowed, *e.g.*, gearing, size of tyres, length of crank throw. Also state your length of leg and weight.

If you have any fear that the machine you wish to buy infringes the patent of a rival maker get an indemnity from the vendor.

Records are little, if any, recommendation. The machines on which they are performed are almost invariably specially constructed, sometimes the design of machine being quite different from the standard pattern. The rider has much more to do with the performance than the machine. These remarks do not apply so much to hill-climbing competitions, though here the gear is apt to be lowered and the crank throw increased. It will often be noticed that all the good rides done on one make of machine are by the same man, who is probably paid to do them.

Beware of machines which are described merely as So-and-so type or So-and-so pattern, &c. This very description shows that there is nothing special about the machine itself, and the chances are that many of the good points of the original are omitted. A good machine will bear a name, but a machine without a name should be shunned.

Be cautious about buying machines, whether new or second-hand, advertised as silver-plated. Nickel is frequently used on cycles, but silver never.

A good machine is cheapest in the end—it gives more satisfaction than a so-called cheap one, costs less for repairs, and sells again at a comparatively good figure.

Perhaps the best course is not to buy a machine at all at first, but to content oneself during the first season with hiring. The same machine should not be hired each time, but as many different depôts visited and machines ridden as possible. This will give the novice experience in the advantages and disadvantages of the various machines, the peculiarities of agents, and extensive knowledge of the surrounding country. Do not wait until the day you wish to ride, but select and book the machine beforehand, paying, perhaps, one shilling, which will secure the machine to you for an hour, so that it will not be let out if you are a little late.

The agent will probably require you to sign a paper and leave a deposit before you start. Your signature to the paper will assert that you have examined the machine and found it in good order, and that you agree to pay for any damage occurring to it before it is returned. For this reason and for your own comfort and safety you should carefully look over the machine before you start—don't take the agent's word for its being all right. See that you have a properly fitted and trimmed lamp, a bell that will ring, and a bag containing spanners that will fit the nuts, and a can with oil in it. To arrive at a fair estimate of the qualities of the machine it must be in proper order. On returning from your ride don't forget to ask for your deposit, which will be handed to you, less the amount payable for hire.

The experience thus obtained can be digested during the winter, and the machine ordered soon after the shows. We do not advise ordering at a show, as the multitude of machines is simply bewildering, and a hasty purchase may involve a lengthy regret. But full particulars should be obtained of those machines which impress you favourably, and the reports of them in the papers noted. The final choice among the three or four thought most suitable may be left to the editor of one of the more practical cycle papers or other person consulted.

If the price of a first-class machine cannot be afforded, you can either buy a lower-priced new machine or a better-class second-hand one. In the former case it is better to go to a first-class firm, as the advantages of a good name at any rate will be obtained, and probably better work and material than would be put in by a house doing only a lower-class business.

Buying a second-hand machine is a much more difficult task than buying a new one, but if carefully done cycling can be enjoyed at a very cheap rate, or maybe at a profit, as a second-hand machine can often be sold for more than is given for it, even after an additional season's riding. In some respects it is not wise to buy machines from friends, as if anything goes wrong (and cycles frequently seem to resent change of ownership by breaking shortly after the transaction) it is apt to cause unpleasantness; on the other hand, it is a great thing to know personally the sort of treatment a machine which it is proposed to buy has been subjected to, and the real reason for its being sold. A good idea of the prevailing prices of second-hand machines can be obtained from the sale and exchange columns of the cycling papers and *The Exchange and Mart*. Good machines may be sometimes picked up at low prices at the cycle auction sales, but this is rather a dangerous method of purchasing. In any case the purchaser should do his best to get a guarantee against defects in material and workmanship for twelve months. The best time to buy second-hand machines is during the last quarter of the year, the best time to sell (and therefore the worst to buy) is just before the Whitsun and Easter holidays. As modern a machine as possible should be selected, and the construction of course is as important in a second-hand machine as in a new one. Sometimes the makers have soiled and second-hand machines of their own manufacture to dispose of at reduced prices, and as they are generally put in thorough order before being offered for sale they are often worth the apparently high price usually asked for them. In buying a second-hand machine the age of the article is an important consideration, not only on account of the corresponding amount of wear, but also because a modern machine is much easier to re-sell than an ancient one. With a view to re-sale, too, it is important to select a machine bearing the name of a well-known maker. It is as

well to take a note of the number stamped on the machine, and refer to the maker, who will probably oblige with the date of its original sale and its list price. The machine should be ridden, the further the better, and the rougher and the more hilly the roads the better, before its purchase be concluded. Do not tempt the would-be seller by asking the age, weight, and other particulars of the machine, but find them out for yourself. Falls and wear detract from the value of a machine. The falls may leave their signatures in deep scratches on the handles, indentations in the outside nuts and ends of the pedal pins, bent pedal pins and cranks, bends and dents in the handle-bar and frame, bent spokes and broken ones which have been replaced by others of a thicker gauge, the wheels being out of truth, and the machine being out of track (*i.e.*, the two wheels not running exactly on one line when the machine is being moved in a straight line). The solid parts and the lower part of the head should be carefully examined for cracks, and an absent spoke may mean that a screw tap has broken into the hub and cannot be extracted without taking the wheel to pieces and putting the hub in the fire—a rather expensive business.

Wear will show itself in the bearings, the adjusting cones being deeply grooved by the balls and screwed up perhaps as far as they will go—which means more or less expense in grinding or renewing. The chain should be detached and the back wheel gently spun; if it stops suddenly it has probably been screwed up for the occasion and overdone. It should die down gradually and oscillate a few times before finally stopping; if it does this, take hold of the rim near the fork or other convenient part of the frame, and press it from side to side; if it rock, adjust the bearing until it is free without rocking, and try the wheel all round to see if it rock in some places and not in others. This would show uneven wear arising from neglect or bad quality of material and work in the bearing. Try the crank-axle and front wheel in the same way. Next examine the teeth of the chain wheels. If the teeth are thin and hollowed there has probably been a good deal of wear, and the parts will soon want renewing; if the smaller chain-wheel be in one with the hub, it would be very expensive to renew. Put on the chain loosely, and spin the driving wheel first forward and then backward, and note whether it runs smoothly on to the teeth, as it should, or is inclined to ride up on the top of them, as it should not. Tighten the chain, and move the wheel round slowly; if the chain be slack in some positions and tight in others, it shows that the chain wheels or even the bearings are out of truth, or that the links of the chain are not equal in pitch. When spinning the wheels, notice if they are true. The *spokes* should be all equally tight. Pull upwards at the handles to see if the head is tight; if not, tighten it, and then turn the wheel to either side; if it

gets stiffer the further it is turned, it shows that the head has not been kept up to its work, and the bearing parts have worn oval. This defect is somewhat important, and cannot easily be cured. The *tyres* show wear by cuts and shape. Sometimes a bad solid or cushion tyre is made to look almost like new by being reversed so that the worn outer side is cemented into the rim, but this adds to the stretch on the face of the tyre, and it will be more liable to cut than when in its natural position; reversing can generally be detected from a rough line showing just above the edges of the rim. Detach the tyres, if pneumatics, and examine the condition of the interior of the cover, the air tube, fastenings, etc. The rubber bars or teeth of the rat-traps of the pedals will also indicate the amount of wear, and so will the step, but not so surely. The brake spoon, in a hilly country, will be more or less worn away, and the joints will be loose if the brake has been used much, but some riders remove their brakes, so this part should not be too much depended on. Never buy a second-hand machine without seeing it and trying it by actual riding, and make the seller state on the bill the name and number of the machine, the maker's name, what parts are fitted with ball bearings, also that he warrants it in good condition. If buying from a stranger, insist on seeing his receipt, for if you buy a stolen machine you may have to give it up without compensation.

When selling your own machine, do not daub it all over with black enamel, but have it properly "stoved"; this is allowable, but turning the tyres and other such dodges are not. If selling through an advertisement insist on the money being deposited with the manager before sending the machine on approval, and do not puff the machine up too highly, or the would-be purchaser is almost sure to be disappointed when he sees it, and decide not to buy; rather let him find it better than he expected, and the chances of the opposite result will be greatly increased. It is usual for the buyer to pay the carriage on receiving the machine, and the seller to pay the return carriage if it be not purchased. Agents will generally allow a fair sum for an old machine off the price of a new one, and sometimes the makers will do the same, especially if the old one be of their own manufacture.

In selecting a machine do not rely on self entirely till you have had, say, four years' experience. Advice is cheap, so the best should be had, and it should be sought with care. When seeking advice from a paper as to selecting a machine, state your age, weight, agility, kind of roads to be travelled over, whether hilly or flat neighbourhood, price to be given, and mention any machines which, after reading this chapter, and examining as many catalogues and machines as possible, may be considered likely. The editor will answer in probably the next issue. Don't bother him

to write a reply per post, he cannot be expected to. There is no objection to sending a postcard afterwards to thank him for advising you in this or other matters, especially if his answer has involved searching, as, for example, in looking up a route.

Friends are apt to recommend their own machines, partly because they have got used to them, and any other machine tried for a short time feels uncomfortable, and perhaps because, if they are not altogether pleased with their choice, they do not like to confess that they have made a mistake. Besides, it does not follow at all that the machine which may suit them would suit you also. There would likely be differences in age, weight, purpose, and ideas of comfort.

Buying through an agent has several distinct advantages. If he keep any stock the purchaser can at least see the machines, and probably compare one with the other, and perhaps try them as well. The machine will be supplied at a discount for cash, or on easy terms, and probably the carriage paid into the bargain. There will be no bother in unpacking an awkward crate and fitting the machine together, but it will be delivered ready for use. On the other hand, an unscrupulous agent is a dangerous man to deal with. His sole idea is to make money by getting as much profit on each machine sold as possible, quite regardless of whether he keep his customers or not. He does not as a rule refuse to give any discount off the list prices; on the contrary, he offers a large discount off a machine which, according to the price in the catalogue, should be a first-class article. This is just exactly what it is not; it is a low-class machine with a high price, so that the maker can give an immense discount to the agent, who can well afford to quote a figure which will entrap the unwary, making them believe they are getting a most satisfactory bargain. Of course, the really first-class makers do not countenance this sort of thing, some of them even stipulating that their agents shall not retail their machines below a certain price.

Most makers and agents will now supply their goods on the easy payment system. Instead of a discount being given, the full list price is usually charged, and the amount, instead of being paid in a lump sum, is divided up into, say, twelve instalments, and one is paid each month. The purchaser gets the machine on making the first payment, but it does not become his own property until the amount is all cleared off. The "hirer" signs an agreement undertaking to pay the instalments regularly, and if under age has to get someone to guarantee the payments as well; in other cases references are often sufficient. A deposit of 5s. or 10s. is made with the order, and is deducted from the first payment. The business is generally conducted fairly enough; the enquiries are made merely with a view to whether the purchaser is good for the

amount, and if he cannot complete his payments the seller will often take the machine back and allow him as much as he reasonably can for it. Still, when the ups and downs (especially downs) of life are considered, we are inclined to think it is best either to save up till one can buy right out, or to borrow from some friend who will not be so likely to claim the machine in case of a temporary delay. If, too, the steed does not give satisfaction, one "looks forward" to the regular visits of the collector with less pleasure than is usually implied by that term.

CHAPTER VIII.

CARE OF THE MACHINE.

Housing, Cleaning, Adjusting, Oiling, etc.

THE machine should be kept in a place that, without being damp, is not so hot as to deteriorate the quality of the rubber. A safety does not take up much room, and if it can be kept indoors so much the better. It should be kept upright, so that the oil does not run out of the bearings, making both cycle and floor in a mess. If leaned against a wall, and the handles are hard, it is for their mutual benefit to put a pad (*e.g.*, the rider's gloves) between the two. The best way is to suspend the machine or use a good stand.

If your occupation or some other reason prevents your riding during the winter, take off the saddle, pedals, lamp, bell, and chain, and keep them in a dry warm place, coat the enamelled and bright or plated parts with a thin but entire coat of vaseline, and see that it is all right at least once a month. If the whole of the machine cannot be kept indoors, the coating of vaseline should be all the more thorough, and as much plated work detached as possible.

Nickel plating is not the exceedingly grateful and comforting advantage one is tempted to suppose. It looks very nice when new, and if of good quality will, with proper attention, continue to do so. But a coat of nickel is not a perfect specific against oxidation, and if the plating chip it often reveals the fact that the steel has been rusting underneath for some time. It is especially liable to come off edges, *e.g.*, the corners of the cranks. The rims and spokes should never be plated—the former get scratched by the stones and grit on the road, and the latter seem innumerable when one tries to polish them, and the rubbing does them no good.

Nickel-plated work should be kept dry and well polished; a strip of buff leather wound once or twice round the part and worked two and fro produces a polish very quickly. If very dull it may be washed with Brookes's soap, and some polishing powder used. Sand, glass, or emery paper or cloth, should never be used, as it will simply scratch the plating off.

Bright parts, which are not plated and which have become rusty, should have some paraffin rubbed on. This will loosen the rust, and a good deal may be removed with a cloth; then two or three sizes (the coarsest first) of emery cloth torn in strips may be applied, and finished up with the finest size emery and some lubricating oil. When using emery on the machine keep the bearings wrapped up so as to prevent any getting in. Sea air tests nickelled as well as "bright" work very severely.

There are many preparations, generally transparent varnishes, for preserving bright parts from rust, but most are troublesome to apply, get covered with dust which sticks on in drying, and so look very bad, and they get rubbed off the exposed parts. Silico enamel appears to be free from these defects, and is a highly satisfactory preparation; it does not come off on the clothes, and may even be washed with water. It may be removed with strong methylated spirit. It is a good plan to apply this enamel to the plated parts when the machine is new. It is not greasy, like vaseline, and its presence is hardly perceptible; as in many other cases, its successful application depends largely on the strict following of the directions.

Enamelled or Painted Parts.—If the machine be dirty with dust or dry mud it should be cleaned dry with a cloth, the lumps being pinched or chipped off with a piece of wood, or, better still, brushed off with a small stiff brush. Soda and water may be used if the mud is very tenacious, but it is best to do without it if possible, as the water is apt to get into the bearings and other parts, and cause rust to form. The enamel or paint may be cleaned with clean rag dipped in paraffin, and polished with furniture cream. If the enamelled parts have been previously greased with vaseline, the mud will come off much easier, and be less liable to scratch. Instead of allowing the mud to dry it may be sprinkled with sawdust, which will absorb the moisture and fall off, carrying the dirt with it. A long narrow spoke brush is handy for getting at awkward places.

To remove the mud from the tyres get a narrow piece of stiff sheet metal, and cut a gap in one end which will fit the tyre loosely; sharpen the other end and fix it into a handle (like those sold for files, etc.) Place the gap end against the tyre and revolve the wheel once or twice, and the work will be done. The rider who keeps his machine in the house will appreciate this when coming in from a dirty ride.

Lubricating the Machine.—The following parts will require oiling: (1) The driving-wheel hub or bearings, (2) the crank-axle bearings, (3) the front wheel hub or bearings, (4) the pedals, (5) the head (at top and bottom), (6) the teeth of the chain wheels, (7) the joints of the chain, (8) the brakework joints, (9) the saddle spring—the latter named least frequently, the former most often. As to

how often to "liquidate," we think we should oil the first three once in at least one hundred and fifty miles under the most favourable circumstances, or if the machine had been lying idle for ten days or so.

The lubricant should in all cases be applied between the surfaces that work on each other; apertures are left for this purpose, and are generally provided with cups or spring covers. Care should be taken to prevent any dust or grit getting in when oiling up.

It is generally advisable to wipe the part around the lubricating hole before moving the cover to prevent any grit working in, and afterwards to dry up any surplus oil, as it would invite the dust to settle on the part. Take care that the oil really sinks in, and does not remain in the cup (especially in the hubs); the part should be worked once or twice to draw the oil in. The oil in the bearing helps to keep out wet. Lean the machine first to one side and then to the other when oiling to distribute the lubricant to both rows of balls.

The brake joints and saddle spring will not require much oil; in fact, many saddle springs are now made without frictional parts, and so do not require oiling—a considerable advantage.

Keep the crank slots, the part of the pedal-pin that goes into the slot, the nut, and the thread free from superfluous oil; this will reduce the tendency of the pedal to get loose. A washer should be put between the nut and the face of the crank with the same object. Do not lean the machine always the same side to the wall, or the oil may flow towards one side in the bearings, leaving the other dry. The bearings should be cleaned and adjusted *after* the mud, dust, and rust have been removed from the machine, as the grit and emery are very fond of quenching their thirst with the oil in the bearings, and having a row with the balls, if possible. To clean out a bearing that has become clotted with thickened oil or grit, fill the oilcan, or, better, a small syringe with paraffin or rectified benzine; mark where the bearing is adjusted to, loosen it out, and squirt the paraffin in at the lubricator and sides, and then revolve the part. The oil will run out very black at first, and operations should be continued until it is nearly or quite clear; let it drain, and then lubricate with a fairly thick oil, such as pure sperm (the paraffin remaining in the bearing will thin it sufficiently), and adjust up to the old position, or tighter, if necessary. The presence of grit or a broken ball can be detected by the ear with a little practice when the wheel is spun. If the paraffin treatment does not effect a cure, the axle and balls should be removed and cleaned. The part must be cleared for action; if a hub, the wheel must be taken out of the machine; if the crank-bracket, the crank at the adjusting end of the axle, and the chain must be taken off.

The adjusting cone or disc is unlocked and unscrewed, and the axle withdrawn in the opposite direction. In doing this, hold the axle up into the bearing with the left hand, with the cone or disc uppermost, and when it is clear hold one hand close up to the open bearing, and carefully turn the balls out into the right hand, see that they are all out, and then turn the part right over on to the right hand, and draw out the axle upwards with the left; shake the part and the balls out of this side will fall into the right hand. Put the balls into a shallow tin of paraffin, and clean the other parts of the bearing thoroughly with a rag saturated with the same oil. If the cones are both in one piece with the axle it will be necessary to remove both the discs. The disc on the chain-wheel side of the crank-axle can be removed, after it has been unlocked, by a pointed instrument put through the chain-wheel into one of the little holes provided for the purpose in the side of the disc; sometimes there is a little hole through the chain-wheel to put the instrument through; if not, put it between the spokes, and bring the crank round to bear against it, and, holding both together, unscrew the disc. If there is room to get a pin spanner (which should be supplied with the machine) into the holes, the disc can be undone with comparative ease. In replacing this disc take care to screw it in just as far as it was before, or the chain wheels will be thrown out of line. A good many find a great deal of trouble in replacing the remaining parts of a "barrel" bracket, but it is not very difficult if you go about it in the right way. We have found the following method satisfactory: Presuming that the disc on the chain side of the bearing, and therefore the axle, are in position, turn the machine on to its chain side; drop half the balls into the bracket, and work the axle up and down until they are over the shoulder and lying in the disc. Then push the axle down so as to hold the balls in place, and wind a cloth round between the chain-wheel and the end of the bracket, or otherwise wedge them firmly apart. Next turn the machine on to its other side, and support it so as to keep the end of the crank-axle off the ground. Then thread the other disc just on to the axle, and put the remaining balls into it, or if there be not room to get them into the disc when on the axle, put one finger through the disc so as to fill up the hole, put the balls into the disc and the tip of the finger against the end of the axle, and slide the disc on to the axle. The disc is next screwed up in place, and when right up the machine may be raised to its upright position, the cloth or wedge removed, and the exact adjustment effected and locked. This is a cleaner and more certain plan than sticking the balls in with vaseline, as the latter loses its consistency as one warms to one's work. If vaseline (or butter or lard) be used it should be worked into the ball races, and the balls stuck into it; it should be washed out afterwards with paraffin.

In replacing the parts of a bearing in which only one cone is fixed to the axle, as in the front hub illustrated, put the wheel flat down on its left side, drop the axle in as far as it will go, and put half of the balls into the upper ball race. Then lift the wheel so that the fixed cone falls into place, catch the axle and hub so as to keep the cone in place with the left hand, raise the wheel, turn it over, and drop the remaining balls into the other ball race, and screw on the adjusting cone until it also is down in position. A "cup and cone" bracket, the rear hub, the pedals, and the head may generally be put together in a similar way. Do each pedal throughout separately, so as not to mix the parts. Always try to put the parts back into their original places, as though apparently alike they may have worn differently. The left side of the steering wheel and of each pedal should be marked before taking the bearings apart, the other wheel and bottom bracket have the gearing, etc., to distinguish their sides, but do not forget that the sides are reversed when the machine is turned upside down. It is convenient to turn the machine upside down for cleaning the bearings, etc., as the parts can then revolve, and are at a convenient height. Lock the steering, if possible. It is not advisable to undo bearings near drain holes, unless one has an unlimited supply of new balls at hand.

The balls in a bearing should all be exactly the same size, else the large balls will get all the work and the small ones none. If a new ball is required in a bearing, the old ones should be carefully gauged, and a new one of precisely the same size inserted; if a new one of just the right size cannot be got, it is best to have a new set.

Adjusting Bearings.—A bearing should be just so tight that it runs freely without shakiness. If too tight, it is obvious that it will not run easily; if too loose, the surfaces, which should work evenly with respect to one another, will be constantly becoming crossed, and will likely get worn unevenly and damage the spindle and case. The correct adjustment of the bearings is very important to both rider and steed.

To see if the front wheel bearings are too loose, hold the fork just above the wheel with one hand, and hold the rim firmly near the same spot with the other hand, and press it from side to side. If there be any looseness it will be at once apparent, and the bearing will require to be tightened; if there be no looseness, spin the wheel gently and let it revolve; if it only turns a few times and then stops dead, it is too tight; if, on the other hand, it runs for a long time and then reverses a few times before it finally ceases to move it is loose enough, and if at the same time there be no side shake it is just right. In a pneumatic-tyred wheel, the valve will, owing to its weight, affect the revolving and reversing of the wheel. If the adjustment requires altering, first see which of the two is

the adjusting cone. It will be provided either with a milled (rough) collar, with which it may be rotated by the fingers, or with flats or recesses enabling it to be turned by a suitable spanner; this cone should be on the left side of the machine. Having found the adjusting cone, see that the nut on the *other* end of the spindle is quite tight. Next loosen the nut at the adjusting end, and screw the cone further into the hub (to tighten the bearing) or out (to loosen it) as may be required. If the bearing be too loose screw the cone in as far as it will go, and then loosen it an eighth or a quarter of a turn, according as it is a coarse or fine threaded spindle; it is easy to see that the finer the thread the more nicely can the bearing be adjusted. When the adjustment is thought to be right screw up the nut tight and try the wheel as at the first, and further regulate it as above if required. After tightening up the nut it may be found that the top of the wheel is nearer one side of the fork than the other; if so, loosen the nut again, hold the rim central, and tighten finally.

The rear-wheel bearings are adjusted in the same way as the front, but before either these or the crank-axle bearings can be done to perfection the chain should be removed, as it affects their running considerably.

To see if the crank-axle bearings need adjusting, remove the chain and spin the axle round; if too tight, it will stop suddenly. Supposing it to revolve freely, the next thing is to ascertain if it be too loose. To do this, bring one of the cranks up level with the back stay on the same side of the machine, take hold of the end of the crank with one hand and the back stay close to it with the other, shake the crank sideways to and from the machine; any looseness in the bearings will be immediately detected. The actual adjustment depends on the construction of the bearings. If the cone screw along the axle it will be like a front wheel bearing, though the locking arrangement may be different. To adjust the barrel bracket, loosen the grip of the case on the adjusting disc by unscrewing the bolt which draws the parts of the split lug together, or otherwise unlock it according to its construction, then screw the adjusting disc in or out as required, and fix it by tightening the locking arrangement. If the disc has only little holes in the side to turn it by, and the proper spanner is not available, take a stiff piece of wire (a long French nail will do), push it into one of the holes and run it round by turning the crank in the desired direction, holding the head of the nail with the other hand.

When it is required to adjust the Æolus bearing the rack screw is undone, the rack removed, and the disc turned in or out, according as it is required, to tighten or loosen the bearing. The disc may be turned by the fingers, or if too tight for this by a sickle-shaped spanner with teeth at the end made for the purpose. In

the absence of this, a piece of string or wire may be crossed again and again in the teeth, not across the disc, but around the edge, and the disc may be pulled round by the free ends; or a piece of rag may be wrapped round the bearing two or three times, and the mass gripped in the ↄ formed by the thumb and finger of the right hand. Of course, these dodges are only makeshifts, as is also the next method, which should only be resorted to in very extreme cases, as it is almost certain to break the teeth off—we refer to putting a screw-driver or a similar instrument in the teeth and tapping the disc round by hitting the other end of it.

The pedals are adjusted like the front wheel, the D washer taking the place of the fork end in preventing the nut turning the cone.

To see if the head be loose, place the machine with the front wheel touching a wall at right angles to it, and standing at the side of the machine push the handles forward; any looseness will be readily detected. If the head be too tight the steering will be stiff, whether the rider be on or off the saddle. But if the steering, which has been free enough, begins to get stiff, dismount at once, as it is probably owing to the head tube or fork crown giving way, a serious defect that calls for immediate repair. The steering should be at least so free that the front wheel will turn to whichever side the machine is leant while wheeling it along. The ball socket head is adjusted like a pedal, but the cone is often locked by a split lug tightening a split extension of the cone on to the head tube and handle-bar stem. A good head very seldom requires oiling or adjusting, but it should not be allowed to remain loose or the parts will wear unevenly, and it will not be possible to tighten it up properly.

The chain should not be quite taut, as that entails additional and unnecessary friction; on the other hand, it should not be so loose as to produce backlash, *i.e.*, the rider should have no difficulty in keeping up a continuous pull on the chain, but a rider who ankles well can drive without inconvenience a machine with a much slacker chain than another who merely plugs. A too slack chain, however, has another fault which affects good and bad riders alike, viz., it is liable to run off the wheels when the machine is running free downhill. The tension, then, should be a happy medium, not so tight as to bind nor so loose as to be likely to run off the wheels. As there are often irregularities in the pitch of the chain and the teeth of the wheels, it is as well to revolve the crank-axle chain wheel bit by bit, and see after each movement that the chain is slack enough.

It is important for the easy running ot the machine that the driving and steering wheels should be in track, and, subserviently to this, it is also important for the running of the chain, and

through this, the machine, that the crank-axle and driving-wheel axle should be parallel. To see if they are parallel measure the distance between the ends of the two axles on one side of the machine, and then see if they measure the same on the other side of the machine. The axles can always be set parallel in machines with backward adjustment, but, as before said, it should not be attained at the expense of correct tracking of the running wheels.

Do not depend on the chain adjusters to hold the wheel in place (they are only meant for adjusting), but tighten up the nuts on the ends of the axle, and so lock it in the desired position.

When a chain has become very dirty it is best to take it off the machine, rub it with a piece of sacking or a coarse door mat or other rough material, and then put it in a pan of paraffin. Stir the chain about well so that the oil gets right into the joints, and then leave it to soak. Next take it out, brush it with an old nail brush, and wipe it, put it on the machine and go for a short ride with it; this will help work the dirt out of the joints. Take it off again, put in a warm (not hot) oven to dry the paraffin out, wipe it, and then put it still warm in some good lubricating oil, and leave it to soak all night; it will suck the oil into the joints as it cools, wipe it again, and replace it on the machine. It is a good plan to have two chains, one in use, and the other preparing, as this allows proper time for soaking and drying. After being run on the machine, the less paraffin there is left in the joints, the better will the lubricating oil be able to work in, and the less will it be diluted. Some dry or semi-dry lubricants, preparations of plumbago principally, are very good, being more lasting than oil, so long as it does not rain, and are less liable to catch the dust. It is handier, however, to make one lubricant do for all parts than to use two or three kinds. In any case we think the dry lubricant is less suitable for the joints of the chain itself than for the teeth of the chain wheels and the parts of the chain they come in contact with. If a dry lubricant is to be used for the chain, the latter must be thoroughly cleansed from oil by the paraffin process, and then the plumbago should be well brushed into the joints. A good dry lubricant may be made of finely-powdered plumbago (black lead) and just enough vaseline to make it hold together.

A good chain cover and lubricator should save nearly all this trouble, but it is as well to have a look inside occasionally, as any dirt that gets in may be reckoned on to stop there until it is cleaned out.

Sometimes when riding on dirty roads without a gear case the chain will get so tight as to make it almost, if not quite, impossible to drive the machine. This is owing to the mud getting caked on the inside of the chain and between the teeth of the wheels, thus increasing the diameter of the wheels. This mud should be cleared

out and plenty of oil used on both chain and wheels to prevent the mud hardening. On a long journey it may be found necessary to slacken the chain in order to prevent frequent dismounts for cleaning purposes. Taking the uppermost teeth on the wheels, it is the fronts of the teeth on the crank-axle wheel and the backs of the teeth on the hub wheel which get most of the friction, and to which, therefore, the oil should be particularly applied.

The handle-bar may usually be set at any height within the limits of the parts. The liability for the bar and stem to twist round in the head is provided against in some machines by making a groove or flats on the stem, and forming the cramp or split lug to suit. This arrangement should insure the handle-bars being at right angles to the machine; with the ordinary split lug the rider must be careful to get the handle-bar parallel to the front wheel spindle, or the brake gear may work badly. It should be remembered when adjusting the handle-bar that the brake will require adjusting too. Both should be carefully secured. Roughly speaking, the handles should generally be about one inch higher from the ground than the top of the saddle.

The brake should be adjusted so that the fingers can just grasp the lever, and yet so that when the brake is full on the brake lever does not touch the handle—in fact, it should then be just so far off that the rider can use the full force of his grip, which he cannot do if the handles of the lever and of the handle-bar are too close together.

The band brake requires very careful adjustment by means of a screw arrangement, which should be fitted so that the band does not touch at all when off, and yet grips as far round as possible when on, and so that the bell crank levers work at the proper angles. The arm of the lever should be exactly at right angles to the rod or tube it is connected to when full on. When the leather wears thin it should be renewed, as it may crumple up under the strain and cause an accident.

If any oil get on the drum it should be immediately and most carefully wiped off. If any get on the leather a little powdered chalk may be dusted on; should this not be sufficient some powdered resin may be added. Resin is rather risky, as it may melt, and it then acts rather as a lubricant than otherwise. But the rider will find its lubricating qualities very disappointing if he tries it in the bearings or on the chain. Be careful, therefore, to keep it away from those parts.

Care should be taken to test the tightness of the brake adjustments by trying to pull the lever to the handle on the handle-bar; of course if it gives it must be readjusted and made quite secure. At the same time, unnecessary vigour should not be displayed, or the heads may be twisted off the bolts, etc. It is a

case of turn and test until it be got right. This will not take long after a little practice.

The above remarks anent the handle-bar apply almost equally well to the saddle-pillar, but of course the saddle must be set in line with the machine, not at right angles to it.

If a nut, *e.g.*, the one holding the pedal to the crank, comes loose often, it should be examined to see if the nut beds down evenly on the crank; if it does not, it should be filed until it does. If this be not the cause, it may arise from the nut being too easy a fit on the screw. This may be cured to some extent by flattening the thread in the screw or in the nut, whichever is the more easily renewed. If on the screw, the flattening should be at the bottom; if on the nut, at the top, so that there may be no difficulty in getting the nut to enter on the screw. Sometimes some resin, or goldsize applied to the thread, or a little tow wrapped round it, or a washer put on the screw before putting on the nut, will do. The washer may of paper, string, copper wire, leather, or metal. A spring washer is best, as it has a tendency to bind the nut on the screw. The spanner sent with the machine seldom fulfils its purpose, viz., to fit all the nuts; this is not so much the maker's fault as might be supposed. Quite likely he gets his saddles at one place, hubs and spindles at another, detachable cranks at a third, and so on, and if the makers of these parts change the sizes of their nuts and bolt heads, what is the maker to do? Therefore, provide yourself with a good wrench. Take care when turning a nut or bolt that the spanner or wrench fits properly, and is right on. If you have no hole in the spanner and no adjustable wrench, put slips of tin or even rag round the nut until you make it up to the size of the next largest hole in the spanner. If a nut or bolt will not turn easily, let some paraffin soak into the thread from above and below; if still refractory, wipe off the superfluous oil, and warm the nut for a few minutes with a taper or gas flame; it will then, in all probability, turn on the spanner being applied. A long-handled wrench is the last resource, but it is liable to snap the bolt off short. A thin coin may often be used to turn a screw when one has not a proper screw-driver. After the rider has got his machine adjusted to suit himself, he should mark the positions of the saddle-pillar and pedals in crank slots and handle-bar with a file, and having made the following measurements, jot them down: (1.) Centre of saddle to end of crank-axle. (2.) End of crank-axle to inside end of pedal (centre to centre). (3.) Centre of saddle behind a vertical line drawn through the crank-axle. (4.) Distance of handles above or below level of saddle. (5.) Width of handles apart. (6.) Distance of a line through the handles from the centre of the saddle. These measurements will enable a rider to adjust a strange machine to suit himself very quickly, allowance being made

for a hard or soft saddle and spring, and for a difference in the width and position of the handles, the handle-bars being raised for wide handles, or those set far in front of the saddle, and lowered for the reverse.

There are quite a number of so-called enamels on the market for touching up parts of the machine where the paint or enamel has got worn or chipped off. They cost usually one shilling for a jar or tin, brush included, containing enough to do about two machines all over. The part to be enamelled should be rubbed smooth with sand paper or fine emery cloth, freed from grease with paraffin, and the enamel applied as thinly as possible, care being taken not to pass the brush over any place twice; the temptation to repeat is very strong, but should be withstood. If one operation is not sufficient it should be repeated after the first coat has set. Some kinds dry in five minutes, and are very handy to touch up a new spoke, etc., when the machine is wanted at once; others take rather longer, but they do not *set* for a much longer period, so twenty-four hours should be allowed to elapse before applying the second coat. To attain the best results, the work should be done in dry weather and in a room quite free from dust; it may be toned down by rubbing the hand over the part when nearly set.

It is best to look after the machine oneself—no one else is likely to take so much trouble with it, and any little peculiarities will be noticed, and the machine treated accordingly.

The rag should be strong and absorbent, such as the honeycomb dusters. It is as well to have two, one for dirty work and the other for finishing off. Waste cannot be used like a strap or band, and the threads are apt to wind round the bearings and get into other awkward places.

Chamois leathers can be washed when dirty, and will not dry hard if the soap be not rinsed out. They should be thoroughly dry to get the best results. Selvyt appears to be an excellent substitute for chamois leather.

After cleaning the machine the cyclist will find that he has very effectually succeeded in transferring a considerable portion of the dirt and grease to his hands. It is hopeless attempting to properly clean a machine with gloves on, but it is a good plan to rub the hands over with glycerine before commencing operations. If this has not been done the following may be tried: First wash the hands in paraffin; this will remove a good deal of the superficial dirt, but some will be left in the lines of the skin; to remove this pour a few drops of ammonia into a basin containing hot water, then rub vaseline or lubricating oil thoroughly into the skin, and rinse them in the water. This will produce a kind of soap exactly where wanted, and with the aid of some Hudson's extract, Venus, or other strong soap preparation, and a nail-brush, the offending matter will be removed with comparative ease. Pumicestone

should be used with care, as it rubs away the skin as well as the dirt, and the former is of limited thickness—in some people. A greasy finger may be wiped on the under side of the saddle leather in an emergency.

To carry a safety, stand on the left side of it, grasp the lower backbone just in front of the bottom bracket by the right hand, and hold the left handle in the left hand. In going up or down steps press the left handle down, so that machine lies almost in a horizontal position. If the steps are not very steep the machine may be wheeled down with the brake hard on. Take care the front guard does not catch on the steps, especially the first one. Safeties are very awkward in trains. Perhaps the best way, if there be room, is to lay them flat down, after taking off the lamp to prevent the oil running out. If you cannot lay it down lean it against the side or end of the van, and put a box or other obstacle to prevent it slipping. Some van floors have laths nailed across. These are better than a box, as they are not liable to be moved. To prevent the machine running lengthways either tie the wheels or put obstacles as before. It is worth while persuading the guard to let you ride in the van so as to look after the machine yourself.

Machines fitted with bath lubricator gear cases should always be kept as nearly as possible in their normal position. Especially be careful not to elevate the front wheel.

RAILWAY RATES.

The following particulars, based on the L. & N.W.R. Co.'s regulations, give the scale or rates in force on most lines:

DISTANCE.	BICYCLES. (See note at foot of scale.)			VELOCIPEDES, TRICYCLES. (See note at foot of scale.)		
	When conveyed as passenger's luggage at owner's risk.	When sent as parcels at owner's risk, including collection and delivery.	When sent as parcels at company's risk, including collection and delivery.	When conveyed as passenger's luggage at owner's risk.	When sent as parcels at owner's risk, including collection and delivery.	When sent as parcels at company's risk, including collection and delivery.
	s. d.	s.* d.	s.* d.	s. d.	s d.	s. d.
Not exceeding 12 miles	0 6	1 6	2 0	1 0	2 0	3 0
,, 25 ,,	0 9	1 6	2 0	1 6	3 0	4 6
,, 50 ,,	1 0	1 6	2 0	2 0	4 0	6 0
,, 75 ,,	1 6	2 3	3 0	3 0	6 0	9 0
,, 100 ,,	2 0	3 0	4 0	4 0	8 0	12 0
,, 150 ,,	2 6	3 9	5 0	5 0	10 0	15 0
,, 200 ,,	3 0	4 6	6 0	6 0	12 0	18 0
,, 250 ,,	3 6	5 3	7 0	7 0	14 0	21 0
,, 300 ,,	4 0	6 0	8 0	8 0	16 0	24 0
,, 350 ,,	4 6	6 9	9 0	9 0	18 0	27 0
,, 400 ,,	5 0	7 6	10 0	10 0	20 0	30 0

Any of the above-named articles carried as passenger's luggage at ompany's risk are charged twenty-five per cent. over the owner's risk rates as above.

NOTE.—This scale of rates (*) will also apply for the wheels of a velocipede, the large wheels of a tricycle, or the wheel of a bicycle exceeding 40in. diameter, if sent alone; but for the other portions of a velocipede, bicycle (including the wheels of bicycles), or tricycle, when sent in pieces, the ordinary parcel rates will be charged.

TANDEM BICYCLES are charged fifty per cent. over the rates for ordinary bicycles. Tandem tricycles will be charged as sociables. (See sociables.)

SOCIABLES.—Sociables, *i.e.*, double tricycles with seats abreast, will be charged fifty per cent. in excess of the scale rates for ordinary tricycles.

The above rates do not apply (with certain exceptions) to places on the London Brighton and South Coast, London Chatham and Dover, and South-Eastern lines, and those companies will not accept through entries for cycles based upon them; nor will they, or the London and South-Western Company in so far as affected by competition with other Southern companies, accept any kind of cycle as parcel traffic unless properly packed.

Machines may be left at most of the railway cloak rooms for about 4d. *a day, provided there be room. The rates at the cycle depôts vary from* 3d. *to* 6d. *per diem for safeties, while some do not charge anything for an hour or two's accommodation.*

REPAIRS.

Repairs may be divided into two classes: those which the rider can do himself, and those which he cannot. The larger the former class, the better for the rider's pocket and general convenience.

In the case of serious damage it is better to send the machine to the maker, if possible, as his tools and parts are adapted to the peculiarities of the machine, and his men are well acquainted with them. If you take it to a local repairer he will very likely have to send it to the maker himself. On the other hand, makers sometimes give scant attention to repairs during the busy season, and one may be kept waiting as many weeks as the job should take days, or even hours. Local men are not always guiltless on this score, but they are more accessible for appeals and reprimand.

When sending a machine for repair it is advisable to detach the saddle, pedals, lamp, tool-bag, etc., etc., as these parts may get lost before the machine returns. Some makers require that the carriage should be paid by the sender. In any case the name, etc., of the sender should be given on the address label, and a letter should be sent stating exactly what is required.

Before definitely ordering the work to be done, it is best to get an estimate of the cost, though repairers' estimates are often unsatisfactory. If contracts, they must be put high to cover risk; if not contracts, they are apt to be quoted low so as to get the job, and then, frequently, a good deal more has to be paid owing to some unforeseen difficulty which may have arisen, as the failure of one part is very likely to damage another, though it may not be visible outwardly. Some repairers are very much inclined to do a good deal more than they are instructed, and then expect one to pay for it. It is best, therefore, after seeing the firm, to write saying what you wish them to do, and if they find anything else is advisable, to let you know before doing it.

A good deal of discussion often arises over alleged "flaws." A manufacturer will usually guarantee his machines against defects in workmanship and material for twelve months, and if the machine breaks owing to a flaw the purchaser naturally expects the defective part to be made good. But what looks like a flaw may be merely the result of a former fall, and if the old wound has got soiled or rusty it may be very difficult to distinguish it from a flaw. Again, vibration has a crystallising effect on metal—the metal becomes fatigued. The remedy of heat is hardly adaptable to a cycle, and so when, after many miles, the machine begins to shed its spokes with painful regularity, it is best to have a new set or sell out—by auction.

However, it is more with the minor mishaps that we have to deal here, such as may be attended to by a handy man, and it is

wonderful how many miles of walking, and maybe carrying, a little ingenuity will save. If you are going to attempt a repair that you have not done before, do not rush at it, but take time to think out the simplest and quickest way.

Tyres.—If a piece of the solid or cushion tyre come unstuck from the rim, take a piece of strong string or copper wire, or a shoe-lace, and cut into pieces about six inches long. Take one piece and twist it round the spoke nearest the middle of the loose place, and then pass each end tightly over the rubber and tie on the back of the rim. Repeat this at each of the spokes along the loose place, and at least one beyond in each direction. Special care should be taken to secure that part of the tyre which is still held by the cement which meets the ground first after the loose part, *i.e.*, the piece behind the loose part when it is at the top of the wheel, as on the driving wheel especially; this is where the tendency to "bag" is. It is little use winding one long piece round the tyre all along and tying it somehow at each end, as it will ruck up, and one cut will loosen the whole thing. The separate tying will last a few miles under favourable circumstances, but some of the tyre-holders will stand much longer than string, etc. The best thing, of course, is to re-cement the tyre. As this takes some time to do, and perhaps longer to set hard, it is well to make shift until a long stop, preferably for the night, is contemplated.

When a convenient opportunity occurs, the temporary fixings should be removed, and if there be enough cement in the rim it should be wiped clean with turps, and the tyre washed in soda and hot water. Next warm the rim with a gas or spirit flame (the heat will not hurt the enamel if it has been baked on) until the cement begins to ooze out under the tyre, press the tyre evenly and firmly into place (taking care not to let the fingers touch the hot rim), and leave it to set. Do not perish the cement by over-heating it, and when done do not place the machine so that the wheel rests on the rubber just restuck, or it will make a long flat on it. If the rubber has been stuck all round, lift the wheel off the ground by turning the machine upside down, and resting it on the saddle and handles or by other means. If there be little cement in the rim, or it has become weak through frequent heatings, scrape it all out and put in fresh. If the rider has no cement with him he will very likely be able to get some Prout's elastic glue at the harness maker's in the village. Soak this in hot water and draw out into long even strips until the desired length and thickness are obtained; warm the rim, and put in the strips lengthwise, thoroughly clean the tyre, and spring it into the rim so that it is not stretched more in one place than another; then gradually warm the rim until the cement oozes out as before. If gas or a lamp cannot be got, a hot piece of iron (*e.g.*, a poker) may be rubbed on the cement in the rim, and this is perhaps the best

way with hollow rims, as they take a long time to warm enough to melt the cement; or enough heat may be obtained, with patience, from two or three candles, or even burning paper, etc.

The best way to use the paper is to roll a big piece (*e.g.*, a newspaper) into the form of a pipe, about 2in. in diameter, and set light to the top end; the draught of air adds to the intensity of the heat. Another dodge, and a cleaner one than the last, is to saturate some rags with paraffin, hold them in position with a pair of tongs, and set alight; when the flame burns low put it out, and repeat the operation. Take care not to let the light get to the oil in the can, and do not pour any on to the rag while it is still alight.

Tyre cement should be tough, not brittle; any that has exuded may be cut off with a sharp wet knife. Rubber cuts more easily on wet stones than dry.

There are several useful tyre-heaters in the market; the handiest are made to hang on the rim, and only require shifting along instead of being held all the time. We have heard of tyres being fixed with varnish and even oil paint, in the absence of cement, but the oil would be bad for the rubber. Stray cement may be removed from the fingers with benzoline or turps.

A spoon brake should be used sparingly on a tyre which has anything tied round it.

Ordinary cuts in the tyre do not matter, but very large cuts may interfere with the action of the brake-spoon. To mend them buy some cement specially prepared for the purpose (dissolved rubber), thoroughly clean out the cut with turpentine, and warm the sides, then coat each side thinly with the cement, press the edges together, tie them so, and allow two or three days for the joint to set. It is a difficult job, and should be done thoroughly.

Pneumatic tyres, as a class, are not much given to getting loose on the rim; their ailments are more in the way of punctures and bursts. Bursts may be caused by over-inflation, or by taking a fully-inflated tyre from a cool place into the sun, or by allowing oil to get on the tyre, and so weakening the parts. The original pneumatic tyre was a terrible fellow to repair. It was necessary to unstitch the cover, unstick the ends of the air-tube, take it out, try it in water, put on a patch, thread the tube back, restitch the cover, and if it did not hold then, repeat the performance until it did. As a contrast to this, a puncture in a single tube tyre is repaired by moistening the walls of the hole with a solution of indiarubber in benzine or naphtha, and, if it be only a small hole, it is sometimes enough to force a little solution into the hole and let a drop of it set on the inside end. But if the hole be at all large it will be necessary to plug it. According to one method of plugging, the hole is enlarged to a circular form by burning with a hot wire or by punching out with a little tool sold for the purpose. A plug of

rubber with a mushroom-shaped head is saturated with solution and forced head first into the hole; it is then drawn up by the tail until the head lies against the interior of the tyre around the hole. The tail is then cut off about $\frac{1}{8}$in. above the outer surface of the tyre. Instead of using a plug, a number of strands of thin rubber cord solutioned as before may be pushed into the hole by a forked wire, and as the strands adapt themselves to the shape of the hole it is not necessary to burn or cut it to shape. In repairing a single tube tyre it is always important to see that the walls of the hole are thoroughly impregnated with solution, otherwise the air is liable to travel along the fibres of the restraining fabric and work out wherever it finds a pore in the rubber. The solution should be allowed to dry, and it is often a good plan to bind the tyre round with solutioned tape at the seat of the injury.

A double tube tyre is repaired differently. The cover is opened so as to expose the part of the air tube that has been damaged, the sulphur is cleaned off around the hole, and the place is coated with solution. A small disc, usually about $\frac{3}{4}$in. diameter, but larger if necessary, is cut from a thin sheet of pure rubber, and is solutioned on one side. When the solution is so nearly dry as to have become "tacky," the disc is placed over the hole and carefully pressed down, especially around the edges. The air-tube and other parts may then be restored to their original position, and the tyre re-inflated. Never attempt to undo a tyre before deflating it, and, if possible, dust over the patched place with French chalk, or flour, or plumbago, before replacing the air-tube, so that it will not be liable to get peeled off or stick to the inside of the cover. The hole in the cover should be dealt with by filling with solution to exclude wet, or, if it be large, some cotton-wool soaked in solution should be pushed into the rubber, and the canvas or other material be protected by a patch of solutioned canvas stuck on the inside. If the cause of leaking cannot be found, detach the air tube from the machine, inflate it to its usual size, and hold it down, valve and all, in a bath of water; a stream of bubbles will show whence the escape arises, and the place should be marked with a copying-ink pencil, and it can be repaired after being dried. Sometimes more than one place will be found, *e.g.*, the puncturing object may have gone right through the air-tube, making two holes; this should always be remembered in making a repair. At other times no bubbles will rise in the water. If so, it will be necessary to stretch the tube piece by piece under the water; this will enlarge the hole, and give the air more chance of escaping. If no hole can be found, the joint in the tube may be defective; it can be unstuck with naphtha or benzine, and the outer part folded back on itself. Both parts should then be thoroughly cleaned and solutioned, and when tacky brought smartly back into position again; but this job had better be entrusted to

the tyre maker. At other times it will be found that the valve or the junction between the valve and tube is defective. In the latter case the fault must be repaired, and the part of the tube should be strengthened by a patch of solutioned canvas. The nut holding the valve may want tightening, but it should never be so tight as to cut the tube. If the machine be fitted with a fixed gear case we do not think it is worth while taking the wheel out under ordinary circumstances, and certainly not if the machine is fitted with a fixed Carter case. Unless the oil be first poured out of the case one cannot very well lay it on its side; but this might be done, or one might support the machine so that the rear wheel is off the ground. In either case, wipe the part of the hub further from the chain and the surrounding parts of the machine clean and free from oil, and then proceed to open the tyre on the corresponding side. If it be a Dunlop detachable tyre, take care to press the edge right down into the centre of the rim, and not to let it slip out as one slides the hands round to the opposite sides of the wheel; one really wants a third hand here, and it is a great convenience to have an assistant to slip his fingers under the bulge of the edge; if help is not available it is generally possible to get a toothbrush handle, or some other blunt instrument, under what little bulge remains after letting go one hand. Hold the instrument in one hand so as to prise up the bulge, and with the other push back the edge of the cover into the centre of the rim until the bulge is large enough to come over the edge of the rim. It is as well to avoid sliding the instrument along between the edges of the cover and the rim, if possible, as it is likely to cut the fabric along the course of the wire. If the position of the puncture be known there will be no special difficulty in repairing it, and if it be not known it will be quite possible to remove the air-tube from the wheel (though not from the frame) and to test it in a tub or bath placed close to the machine; the tube can be hung down round the covered end of the hub during the operation.

If a cover will not go back properly into place, it is probably because the wire is somewhere resting on part of the air-tube instead of directly on the rim. If the tube be inflated under these circumstances it will burst, and require a patch a good deal more than $\frac{3}{4}$in. in diameter to repair it. To prevent this, as soon as the air-tube is put back in the rim it should be partly inflated, and care taken, in replacing the cover, to keep the air-tube away from the edges.

Repair outfits, consisting of compressible tubes of solution, patching rubber, and a few other items, are sold, but when bought are frequently left behind. Thin sheet rubber may sometimes be obtained from the dentist. Adhesive tape, or sticking plaster, or even gummed paper, such as a stamp, may be pressed into service to temporarily heal the air-tube. If a very small puncture cannot be

discovered one may pump in some water, preferably thickened with sugar or flour, which in trying to escape will fill up the hole. If the valve has been made of porous metal and leaks, it should be varnished over.

Brooken and Loose Spokes.—A good rim, especially if hollow, will not deflect much for some time, if it lose a spoke or two, unless the wheel be very highly tensioned. Spokes generally go at the rim or at the hub, or in the case of butted spokes, just above the butt. If a direct spoke break off short at the hub the short piece had better be left alone, but in the other cases both parts can be got out pretty easily. It is best to carry spare spokes, or to make shift until some are obtained from the makers, as the local repairer's wire is almost sure to differ in size, and his screw plates in thread, from the spokes of your machine. If the wheel is fitted with plain direct spokes, and the rider succeeds in getting the broken parts out, he can easily put in a new one with a spoke tightener or hand vice. A single butted spoke is not so easily put in, as the hole in the rim is made the size of the wire, and not large enough to pass the butt through, so it has to be put through the rim from the butt side (the tyre having been previously loosened), and headed afterwards. Heading a spoke without the proper apparatus is rather awkward, but the following makeshift will do: Take two pieces of flat iron and file a groove in each nearly half the thickness of the spoke, file out the grooves at one end so as to fit the underside of the head, grip the wire between the two pieces of iron in the vice, and let the end stand through about $\frac{1}{8}$in. The head may be then formed by hitting the projecting end with a hammer; a little oil on the face of the hammer will prevent the wire splitting. The diameter of the head should be twice that of the spoke. Laced spokes can generally be easily replaced, as they almost always break at the hub, but if they break off short at the nipple it is rather awkward, unless the rider has a spare nipple.

If the rider has no spare spokes, or until they can be obtained, the defect can be temporarily repaired in the case of a direct spoke broken at the hub as follows: Bend up the free end of the spoke and twist it round itself so as to form a loop. Take a piece of strong string, whipcord, or wire, and pass it alternately between the other spokes round the flange, and tie the ends loosely through the loop at the end of the broken spoke. Put a small strong piece of wood (or something else handy) between the two parts of the string an inch or two below the loop and twist it round, carrying the pieces of string with it, until the whole affair is drawn tight, then turn he piece of wood at right angles to the broken spoke, so that it will rest against the other spokes without untwisting and in place, taking care that it will clear everything as the wheel goes round. In tensioning up, the rider should watch the rim to see that he

pulls it true, and no more. The spokes next on each side of the broken one (running to the opposite side of the wheel) may be loosened a little, and those next again (running to the same side of the wheel as the broken one) tightened, so as to ease the truing, but if this can be avoided so much the better.

If the spoke break at the rim, move the tyre and take out the broken-off head. Double a thin piece of wire or a strong piece of cord and pass it through the hole in the rim, preventing its going right through by putting a piece of stiff wire or something similar (*e.g.*, a small nail) through the loop. Unscrew the spoke a little, and hook it into the wire (or cord), then screw the spoke up again as tight as required. Refix the tyre, and off you go.

In doing the above repairs take care that nothing can project from the spokes so as to catch in the rest of the machine, and if you have to put anything inside the rim to hold a loop, let it be as small as possible (a headed piece of wire would avoid any lump), as the consequent lump may interfere with the tyre or the brake.

If a direct spoke frequently shakes loose follow the directions given with regard to tightening a nut or a screw. The thread in the hub cannot easily be flattened to advantage, but a few light taps on the side of the flange outside the hole will answer the same purpose, or a piece of paper, tin, etc., may be put in with the spoke.

Some butted spokes are now made with a thick part under the head of the same size as the butt, so that the hole in the rim may be drilled large enough to let the butted part through, and yet is filled up when the spoke is screwed tight. These spokes are as easily put in as plain direct ones, but in some, at any rate, heat has to be employed in forming this thick part, which spoils the temper of the spoke, and weakens it locally.

Buckled Wheels.—When a wheel is completely buckled an end view of it represents an elongated figure 8. It arises from a severe blow or twist, and has a most disastrous appearance, but is not really half as bad as it looks. It may usually be remedied as follows. Lay the machine on its side, or, better, take the wheel out, and lay that alone on its side, and while you press down the parts of the rim that bulge upwards get someone else to pull up those that are warped the other way, and it will in all probability spring back nearly true. Tighten up the loose spokes and secure the tyre if it has been forced out of place. If you cannot get anyone to help you, turn the wheel so that one of the parts that is warped towards you is at the top, tie this part securely to a post, put your foot against the other bulging part of the rim (at the bottom), and pull the two sides towards you with your hands.

If the wheel will not come quite true it had better be returned to the makers, and they will set the rim or put in a new one if necessary.

Truing a Wheel.—Wheelmakers, like poets, are born, not made, and even those who are born require practice in order to become proficient. The ordinary cyclist will be wise who decides to do as little wheel-truing as possible. Still, repairing spokes and unbuckling wheels involve a certain amount of truing which is almost always necessary, and he had better know how to do it. Place the machine so that the wheel to be trued will revolve, spin it, and hold a piece of chalk near the rim, steadying the hand on the fork or frame. This should be done on each side of the rim. The chalk will mark the parts which project out of their proper line. If the wheel is so much out of truth that it touches the fork and will not spin, the chalking may be dispensed with until later on. First true the wheel sideways. Slacken the spokes from the projecting side to the flange of the hub on the same side, loosening the spokes at the middle most, and the others less and less to the end of the bend. Then tighten the spokes running to the other flange to a like extent, *i.e.*, those in the middle of the bend most, and the others less in proportion. When the wheel has been got true sideways by repeated chalking and screwing, it should be spun again, and the chalk held against the top so as to mark any protuberances on the periphery. These should be smoothed out in a similar way to the side bends, *i.e.*, the spokes in the middle of the bends must be tightened most, and those farthest away least, no regard being paid in this case as to which sides the spokes run to. Hollows in the periphery may be detected by holding the chalk under the rim as near the spoke heads as possible while the wheel is revolved. They may be let out by reversing the directions given for drawing in the protuberances.

When the wheel is true all the spokes should be at equal tension, but if the truing has been necessitated by an accident the chances are the tensions will vary considerably.

If when the spokes on the bent side are quite loose, and those on the other tight, the rim still refuses to come over, the wheel must be laid on three or more blocks with the bend projecting upwards, and with a block under each end of it. One or two mild blows with a mallet or other convenient piece of wood will materially assist in straightening the rim. Great care should be taken not to dent or crack the rim, and it had better not be tried with hollow rims, except in extreme cases.

A direct spoke will not always turn as easily as it should do, and force will only succeed in snapping it off. Sometimes the head rusts in the rim and sticks, or the spoke may be screwed right down to the bottom of the hole in the flange. In the first case, the tyre should be loosened, and some paraffin applied to the head of the spoke and allowed to work in; some more may be put on to the spoke close up to the rim. After a little time the spoke tightener

should be put on close up to the rim, and moved gently to and fro until the spoke moves quite freely. If the spoke be fast at the flange the same means may be adopted as at the head, but if the spoke will unscrew, but not screw in, it must be unscrewed and shortened a little or threaded further up the spoke, whichever is necessary. It is as well to use two grips on each spoke, one at each end. Where several spokes are loose next to one another on the same side of the wheel, each may be crosstied to those next to it, first to one, then to the other, until a sufficient tension is obtained.

In case of a fall of a safety the most likely parts to get damaged are the pedals and cranks.

If the **pedal pin** be bent so much that the pedal will not revolve, the latter should be taken off carefully, so as not to lose the balls. The machine can then be ridden with the foot on the pin, or if the rider cannot keep his foot on he can adjust the pin of the crank to a shorter throw, and ride with the pin under the instep just in front of the heel. On reaching a forge, the pin may be warmed and gradually set straight, care being taken not to snap the pin nor to injure the bearing surfaces. The pedal may then be replaced and the rider proceed.

A **crank** but slightly bent is generally easily got used to in riding, but if it catches, or otherwise renders the machine useless, and cannot be detached, it may sometimes be straightened by standing with both feet on the pedal and pulling down after having placed the crank in a suitable position. This is liable to buckle the wheels and do other damage, as it puts a great and unfair strain on the machine, which should be supported under the crank head, on the bar of a gate, or in any other way that may offer itself. If the crank be detachable, take it off and ride with one foot to the next place, where it can be straightened in a vice. It is generally best to do it **cold.**

If the key begin to work loose in a fixed crank it should be attended to at once, when it first shows signs of looseness, or the flats on the axle and in the crank-hole will very soon be spoiled. It is almost always necessary to have a new key, as if the old one is driven in again it is no more likely to hold than before. For the time being, however, it may be so treated, after the axle, crank-hole, and key have been freed from oil and preferably rubbed with a little resin. Do not turn over the head of the key, or it will not drive in far enough; if there be room, put in a little strip of tin with the key. This piece of tin should be about the same width as the key, and about ¼in. longer; the extra ¼in., or a little more, should be bent over at right angles away from the key-hole, and as it bears against the crank face or axle end will prevent the key taking the tin in with it and crumpling it up inside; the little extra piece may be broken off when all is secure.

To prevent the key coming out a little round plate, large enough to cover the axle and key, may be fixed on to the end of the axle with a screw in the centre. When driving the key in, let the other end of the axle rest against something solid.

If a detachable crank work loose, the taper cotter or pin must be driven in further; if it come so far through the other side that the nut will not bed down on the crank, an extra washer must be put on (perhaps the one on the other crank cotter can be spared), or a piece of tin may be put in, as with the fixed crank. In knocking out the pin, do not take the nut right off at first, but unscrew it just so far that the top of it is level with the top of the pin, then the blows of the hammer will not swell the screwed part too much to let the nut be put on again. When knocking the pin in or out, support the head of the crank on a block, so as to let the block receive the shock instead of the whole machine. The support must be so arranged as not to interfere with the driving of the pin.

Loose joints, in the brake, for example, may be tightened and prevented from rattling by inserting thin washers of tin or paper.

Avoid hammering bent pedal pins or cranks; they are liable to snap. Mild steel is often more brittle when just red hot than when hotter or colder; it is not often necessary to get it as hot as this, nor is it advisable, as it may cool to a slightly different size in some of the fitted parts.

A bent handle-bar is got used to even more quickly than a bent crank or pedal, and, like them, should not be straightened unless really necessary, until proper means can be adopted. This advice applies with its greatest force to hollow handle-bars. But if the bar is so badly bent that the machine is unrideable, turn it upside down (don't forget the lamp and bell), and get someone to stand on one side of the bar while you put your weight on the bent part so as to straighten it. If there is no one handy, detach the bar from the machine, bind the straight part to your old friend the gate-post, so that the bent part projects above it and forwards from the side it is bound to, get behind it, and haul away, not until you snap it off, but until you get it just straight enough to be usable, and no more.

Bending Tube.—First fill the tube with dry fine sand, or run molten lead into it; this will help prevent the tube flattening, and will also help to retain the heat. Plug up the ends securely, and warm it at the bent part in the fire. It should not be got more than red hot, and a good deal less heat will probably do. Hold the tube in the vice close up to the bent part between two blocks of wood that have previously been grooved out to fit, and gradually pull it straight. If the tube cannot be filled, it will be all the more necessary to use the grooved blocks. Except in cases of extreme urgency, we should advise no rider, unless skilful as a mechanic, to attempt to bend tube, especially if it be of very thin gauge.

A broken handle-bar may be temporarily replaced by a stout stick or piece of wood bound to the remaining half of the bar. The binding should be done with copper wire, if possible, as the vibration and strain stretch string very quickly. We have made a machine rideable with a strong walking-stick and a couple of handkerchiefs. After you have bound on the stick (the end of which should stand out the same distance from the centre as the handle on the other side) as tightly as possible, make some taper wedges and drive them into the fixings.

A broken hollow bar or other tube may frequently be mended by turning a wood or iron rod to the size of the inside of the tube, and pushing half of it into each part of the broken tube. The two ends of the tube will probably be bent at the fracture. These will require to be straightened out on the point of the anvil with a light hammer. If the parts can be drawn together with double wire tensioned up by a tourniquet, like the spoke, so much the better. An iron or wood clamp, something like the blocks used in straightening a bent tube, should then be screwed on tight over the join. Any other ties and stays that can be fitted up to support the part should be taken full advantage of. A few moments spent in quietly considering what strains the part has to bear and how best to meet them will be well repaid. Do not be afraid of having the clamps large, especially if of wood. We were once enabled to ride a semi-diamond framed machine about sixty miles with the lower part of the diagonal or "down tube" nearly broken off, simply by judicious tying and tensioning.

Broken Chain.—If the chain break, and it is not one of the detachable variety, put it in your bag, take off your pedals (and cranks, too, if possible), let down your saddle so that you can touch the ground with both feet at the same time, and ride off to the nearest locksmith's *à la* hobby-horse. If you have spare links with you they can be fitted in, if not rough ones must be made. See that the links work properly, and that the rivet heads are properly burred over. If you have a companion, make up a tow rope out of the broken chain, handkerchiefs, etc., tie one end to the back of his saddle, and passing the other end by the left side of your head tube, hold it in your right hand. Be careful to follow exactly in his track, and to cast off if you are in danger of overrunning him. An elastic link in the rope is a great improvement.

If a **saddle spring** break it is generally in one of the coils. Get a round piece of wood, which will fit into the broken coil and its fellow, and bind the parts in position with wire. It is quite possible to ride a considerable distance standing on the pedals and using no saddle at all.

If you suspect the machine does not track, ride it and examine the marks left by the wheels, set the steering wheel straight with

the backbone, screw the head up pretty tight, and wheel the machine through dust or mud without moving the head; if it makes two lines, of course it is not in track. Do not attempt to set it yourself, but send it to the makers; if not, to the best repairers you know.

In the case of a wheel being so damaged that it will not turn round, the steering should be locked and the machine trundled along on the sound wheel in such a position that the weight of the machine is balanced on the wheel, and falls as little as possible on the walker. If the frame or other part be broken so that the machine is in two parts, and splicing is out of the question, one part may be trundled and the other either carried in the hand or on the first part.

From the above remarks it will be evident that it is advantageous to carry the following articles, on long rides at any rate: Spare bolts, nuts, washers, spokes, links of chain, spanners to fit all nuts, and a screw-driver, one or two spoke-grips, some tyre fasteners, a stick of cement, a piece of resin, pieces of copper wire and string (*e.g.*, well-stretched whip-cord), and some slips of tin of various thicknesses. A separate tool-bag containing these articles may be kept and carried when likely to be wanted, which some wise people would say means always.

CHAPTER IX.

DRESS.

THE vulgar gauntlets, jockey caps, and heavy braid trimmings of the earlier cycling days have fortunately died the death, and now any cyclist, unless he still cling to the gaudy finery of long ago, can pass unnoticed in almost any town or place.

Comfort is no doubt the first thing in dress, but for the sake of the sport one should look, at least, neat and respectable.

"All wool" is the cyclist's motto, so far as his dress is concerned. We do not go so far as to say that the cyclist who wears all wool will never have a cold, but we do say that it will save him from a great many, and that he will run far less risk than if his linings, pockets, etc., were of vegetable fibre; he will also find that if he get wet through he will not feel cold nearly so plainly as he would otherwise—indeed, the chances are that he will not feel cold at all, and that in about twenty minutes his underclothing will be quite dry. It is no fad, unless one can say that the sheep and oxen and all other beasts of the field are subject to the same fad—they are all clothed with animal fibre, and can lie on the wet ground without taking cold. Why should man be different? Wool is a bad conductor of heat, so that he who wears it has a better chance than other people of keeping cool in summer and warm in winter. Wool loosely woven allows the noxious exhalations of the skin to escape, while cotton and other vegetable substances retain them—a linen shirt gets foul at once if the wearer perspires, but a woollen one will remain sweet for a long time.

The necessity of wearing wool when practising any athletic exercises is now so generally acknowledged that we hope we need say no more on the subject.

The suit should consist of coat, waistcoat, and breeches. The C.T.C. grey cloth is made specially and only for the club; it looks very well without being conspicuous, lasts a very long time, the pattern being a small check it mends neatly, it is all wool, and cheap at the price. It does not show dust nor oil stains so plainly as many patterns, and if it should go rather yellow, the original colour comes up well on being cleaned or washed. It is made in three thicknesses, all at the same figure. If it be decided not to join the C.T.C., some other material must be chosen. If the tailor you go to is not

one appointed by the C.T.C., and he informs you that he can supply you with the C.T.C. cloth, ask him for patterns and fly. Send the patterns on to the C.T.C. offices with a note of the tailor's name, and go to someone else who does not live upon imitations. The new brown C.T.C. cloth has an advantage in being of a looser texture, and is, therefore, less stuffy than the grey.

The Coat should not be too thick; additional warmth may be provided by the waistcoat when needed. Either the thick or medium C.T.C. cloth unlined, or the thin lined, will be found heavy enough. If you do not have the C.T.C. lining, have something that goes well with the cloth and is all wool; it will be worth the little extra charged. A single-breasted cut-away jacket reaching just below the saddle at the back is the best style to have, as it may be worn apart from the machine without attracting attention. The collar should be rather wide, so as to afford full protection in rough weather; to the same end the little piece made to button across the opening should be triangular, with the apex downward, and a button-hole at this point to go on to the top button of the coat. This will make it too large to go under the collar when not in use, but it can be carried in one of the pockets.

A little watch pocket should be made in the edge of the left front of the coat; if made in the breast pocket the handkerchief is liable to get soiled by the frequently dirty gloves. The sleeves should be cut large in the arm-hole, and not too long. A hook and eye may be fitted on each cuff, so that it may be folded and secured close round the wrist in cold weather; elastic bands, straps or string, may be used as rough substitutes. Four buttons down the front will generally be found sufficient, and if they are wired on instead of sewn so much the better.

The Waistcoat should be intended more for comfort than show. It should be wool lined, the back being the same as the front; and cut pretty high in the neck all round. The opening may be at the side; this, besides making it more difficult for the wind to blow in, avoids the multiplication of double edges and rows of buttons all in a ridge down the middle. The usual pockets may be put on, and a button-hole in the centre to carry the watch chain. The waistcoat should be carried on the machine when not in use, as even the hottest days get chilly by comparison in the evening. Great care should be taken not to get a chill when putting on the waistcoat. If waistcoats were made with sleeves, and coats without, this danger would be avoided, as the coat could be carried and put on when wanted. We believe such garments have been tried, with considerable satisfaction to their wearers; the alteration does not seem to affect the appearance.

The Breeches.—Trousers are not convenient to ride in; they drag at the knees, get baggy and oil-stained near the ankles, and

loose knickerbockers are now the only wear. The exceedingly tight breeches worn by some men, besides being barely decent, confine the muscles uncomfortably. The breeks should not be cut too high, or they will chafe the ribs, and plenty of room should be left round the waist. A tailor who makes a speciality of cyclists' clothing should be patronised, for these garments at any rate. Authorities are divided on the question of wearing braces. Some say, emphatically, yes, and others with equal assurance, no. Our experience is as follows: If no braces are worn there is an uncomfortable feeling of slipping down, which leads to an unlovely habit of "hitching up"; if a belt be worn the feeling is to some extent relieved, but the demon dyspepsia soon makes his appearance, and hernia is invited. Elastic braces get damp and cold, but woollen braces keep dry, and the dragging at the shoulders objected to so strongly by the "no braces" party is seldom, if ever, noticeable, especially in the saddle. All we can say is, if your braces are too tight loosen them.

The breeches get pretty hard wear, so they should be of thick or medium material, lined round the waist. They should be double-seated, and the "strapping," as it is called, should be amply large, as to sit on the turned-in edge is particularly uncomfortable, and the back corners of the saddle require guarding against; it should extend forward of the seams on the inside of the legs. Great care should be taken in fitting on the strapping to avoid any chance of its working into creases. It adds materially to the rider's comfort. The strap and buckle at the back are usually fitted much too high up, and are practically of no use when wanted, *i.e.*, when the braces fail. Breeches pockets opening at the side are more easily got into than those with the aperture at the top; they should not be too long. One or two hip pockets opening diagonally and with flaps and buttons will be found useful, and may be fitted in addition to or instead of those just mentioned. The legs should be of good length, and fitted at the ends with two holes and buttons, and a strap about an inch wide sewn on separately with the warp lengthwise. The end of the strap should be finished off neatly, so that it will slip into the buckle freely and without catching. The back part of the buckle which holds the end of the strap down should be raised a little, so as to allow the strap being easily passed under it.

The Stockings should be of thick wool and ribbed. Nothing looks neater than black, though grey goes very well with a suit of the same hue. They should not be too long. How to support the stockings has always been a difficult question to answer satisfactorily. The most usual way is by an elastic garter below the knee. This cramps just those muscles which ought to be free, and impedes he blood, sometimes even causing varicose veins. A garter above

the knee is little, if any, better, being specially severe on the cords at the back of the leg. Some wear stockings which, by shaping and tightness, cling to the leg without additional support, but they should not be too tight. Another way is to roll the stocking down to just below the knee, and then fasten the strap just below the roll. This is only less bad than the garter, and is decidedly warm. Some use suspenders attached to the top edge of the stocking by clips, and are fastened at their upper ends to buttons sewn inside the legs of the breeches, or to a band round the waist. The metal fittings soon corrode, the elastic straps get foul, and while in use they chafe the legs. They are bad enough when standing, but much worse when sitting on the saddle. The desiderata in a stocking support are, that it should hold it up without allowing the stocking to resemble a pagoda, without pressure on the muscles, blood-vessels, or knee joint, and without chafing or other discomfort. In the days of fairly tight fitting breeches we could pin the stockings to the breeches with safety pins, but that plan is hardly available now. Turning the stocking down over a very wide easy-fitting garter is perhaps the best plan; or the friction against the pants, if worn, may be sufficient.

If the stockings chafe the feet, they may be changed over or even turned inside out, and the part which comes against the sore place may be greased with soap.

Blisters are sometimes very painful and awkward to treat. One way is to drop some tallow from a lighted candle and some whisky into the palm of the hand and rub on the blister, the idea being that the tallow softens the skin and the spirit helps the water to evaporate. Another is to take a needleful of worsted, pass the needle through the blister, and leave the worsted in, cutting it off with nearly an inch hanging at each end; the worsted will draw the water by capillary attraction, and the loose skin may be removed with a small pair of scissors after a few days, when the underneath skin has got hard enough.

Underclothing.—If it be desired to wear pants the combination garment had better be adopted, with the object of reducing the chance of creases. Some riders go in for "shorts."

The shirt of all things should be all wool. The C.T.C. shirts are made of the club flannel, similar in pattern to the cloth, but so far as our own experience goes, they appear too closely woven. The Jaeger shirts are very good, the details being specially well attended to; their prices are certainly not excessive.

In America, frequently nothing is worn over the shirt in hot weather, the coat being strapped to the handle-bar. If it be intended to do likewise on this side the herring pond, a dark colour should be chosen for the shirt—if it can be got, which we doubt, in stockinet at any rate—and a pocket provided for the handkerchief.

The Shirt, Collar and Tie.—We have tried all sorts of things to get a comfortable and presentable finish round the neck. A linen collar soils and gets limp and clammy very quickly; waterproof or celluloid collars often crack at the button-holes, turn yellow, cut the neck, and are like an oven one minute and an icicle the next. Flannel collars shrink dreadfully, and are very hot. Perhaps the best arrangement would consist of a merino cellular collar, died coffee colour, with turned down flaps only (we believe this style is called "Shakespeare" in linen collars). Small hooks under the points would catch into loops or eyes on the shirt, and a small bow or knot without a band would complete the equipment. The new sweaters with turn-down collars make that burly garment much more presentable.

The Headgear.—This should be cool in hot weather and warm in cold. It should protect the eyes if the sun be in front, and the nape of the neck if at the back. It must also protect the head from rain, and should not itself be injured by wet. We think a woollen cricket or golf cap will be found to answer very well; the peak can be turned towards front or back according to the direction of the sun. In hot weather, a cabbage or large dock leaf may be put inside, or the outside of the cap be sprinkled with water, the cold set up by the evaporation keeping the head cool. A straw hat which presents so much surface to the wind as to require a guard is in itself a nuisance. We have found that in windy weather a bad headache is very liable to result from carrying too much topsail.

Shoes.—Boots should never be worn for cycling, as they interfere with the free play of the ankles. The ordinary Oxford shoe does very well, but some of the shoes made specially for cycling are the thing. The soles, instead of tapering off to a central point, should be nearly or quite straight on the inner side, curve round the front of the toes, without being either too short or too long, and come well out to the full width of the foot on the outside. The sole should be clumped, and if rat-trap pedals are used, the clump should be cut through transversely in two places, so that the plates will fit into the cuts. To find the position for the cuts see that the teeth of the pedals are fairly sharp, ride the machine for a few minutes, taking care to place the feet correctly and comfortably on the pedals, and not to shift them about. The cuts should then be made according to the teeth marks. Unless correctly fitted they will be very tiring to the joints of the leg, and for this reason shoes ready fitted should not be bought. These cuts will not interfere with riding with rubber pedals or with walking. The waist of the shoe should be flexible, and the heel low. The uppers, for real comfort and freedom from wet and cold feet, should be of woollen canvas, similar to those sold by the Jaeger Co., although these may not

last very long. We have found the horseskin cycling shoes the best. Horseskin, or crup, looks more like bladder than ordinary leather, and it certainly seems very free from cracking. It is a convenience to have the opening in front cut an inch or so further down than is usual in walking shoes, and to have hooks instead of holes for the laces.

Light coloured shoes make the feet very conspicuous. Canvas shoes are cheaper than leather, and are cool.

Gloves.— The gloves should have no buttons or other fastenings which could damage the wrist in case of a fall, and should be plain on the palm. Leather gloves are perhaps best, and they may be ventilated by taking out the small diamond-shaped pieces between the fingers. Wool faced with leather answers very well, but unless the leather be strong the tips of the fingers very soon wear out, and are not easily mended. It is often a relief to take off the gloves for the last twenty miles or so of a long run.

If **waterproofs** are used at all it should be simply as a shelter, and unless absolutely necessary the rider should not ride hard while wearing them, as they retain the exhalations of the skin to a most objectionable extent. They should be long enough in front to come well over the handles, thus affording some protection for the knees also.

Tinted **glasses** are a great relief when the sun is glaring, and they are also a protection against flies. Pince-nez are not much good, as the vibration shakes them, and they are apt to slip off if one perspires much. Spectacles, or even goggles, are best, and the wires should be curled down behind the ears to keep them steady. We do not think the chance of the glass breaking into the eyes in the event of a fall is worth considering, but unbreakable glasses are to be had, or were.

Grease spots may be removed with benzine, turpentine (turps), or ammonia. Rub a piece of flannel, saturated with the liquid, all round the spot, and then gradually work in towards the centre. Benzine is highly inflammable, and ammonia should be handled with care. Another way is to cover the spot with a piece of clean blotting paper or brown paper, and press with a hot flat-iron. The longer a spot is left the more difficult it is to remove.

CHAPTER X.

FOR LADIES.

DURING the last few years, the suitability of the rear-driving safety for ladies' use has been amply demonstrated, our American cousins and French friends especially being alive to its advantages over the tricycle. Cycling is in some respects better for women than for men. Dr. Edis, the senior physician to the Chelsea Hospital for Women, says: "I invariably recommend young ladies to take to cycling with the object of improving their general health and giving them a healthy tone, both mental and physical, and I can safely say I have never had to regret it in a single instance"; and many more quotations of a like nature might be made. On the other hand, little good, if not great harm, will be derived from too long or too fast rides on a too heavy or too highly-geared machine.

It is not every lady who can equal the late Mrs. Allen by riding two hundred miles or so in a day, but most will be able to ride for more hours than they could walk, and from the way we have seen slight girls ride up hills we should imagine that, for some reason or other, inclines do not present anything like the same difficulty to them as they do to men.

Some of the lady pioneers of cycling certainly did present an alarming appearance, and their doubles are still occasionally conspicuous at the holiday resorts. But the genuine lady cyclist, neatly dressed and nicely mounted, is a pleasing spectacle that calls for no fair criticism but what is favourable.

We will deal with the machine first. Unless the rational dress be adopted the framework must necessarily be carried low between the wheels. This prevents the adoption of a design in which strength and lightness can be combined in the highest degree, so the requisite strength has to be obtained by the addition of metal, which means increased weight to some extent. But as a lady does not strain her machine so much as a man, weight may be cut down in other directions, so that unless for heavy weights the machine need weigh little more than a man's.

The best design for a ladies' safety is a matter of some contention. The back and the front need no alteration from the

accepted diamond frame for men, but in the connection of these two lies the difference. A single curved tube of large diameter, running from the crank bracket to the head, is certainly the most graceful arrangement, and it allows most dress space; but it is usually advisable to stay it at the lower end, as the strain there is specially severe. A single straight tube is no doubt more rigid, and it allows enough dress space. But frames with double backbones are more common than the above; sometimes one, sometimes both the tubes are curved, at others both are straight. In the last case the most usual plan is to bring the tubes one from each end of the head, and let them converge towards the bracket. But this, we think, is a mistake. Remembering the duties of the frame, it should be as deep as possible in the centre and as small as possible at the ends, hence the two tubes should start at a good distance apart at the bracket and converge towards the lower part of the head. It is quite possible to get sufficient dress space in this way, and, on the whole, we are inclined to consider it the best. The back of the machine is necessarily built lower than it would be for a man, and to avoid an ungainly appearance the front should be lowered too. There should be plenty of room between the saddle and head, and the handles should be brought well back to prevent stooping. It is bad enough to see a man stoop, but a woman will never condescend to this if she have any respect for the sport. On the other hand, there is no need to have the handles so high as to lose all power. The gear should be low; cranks fairly short, say six inch; the pedals should be narrow, and without the ghost of a spike on bar or plate to catch in the dress, and should have caps over the ends to prevent the oil leaking out.

The dress-guard is a most important detail. Do not, as you value your personal safety or your dress, be persuaded on any account to mount a machine that has not the chain and chain wheels thoroughly guarded. If the dress catch in the gearing it will not come out again, but gradually wind up, until it drag you out of the saddle and probably cause a severe accident. The dress, already mangled beyond recognition, will either have to be discarded on the spot or—however, we will draw a curtain over the rest, though probably you would not be able to do the same. The gearing should be really covered by a complete case, and the wheel should be guarded to prevent the skirts blowing into the spokes. Leather wheel guards usually look rather heavy, especially if they extend back to the mud-guard stays, as they certainly should, but they are perfect in their safety. Perhaps the best arrangement consists in fixing a series of gutta-percha cords nearly horizontally (not radially) from the mud-guard stays to the back stays of the frame. The rear-driving safety offers better opportunities for shielding its fair burthen from mud than the tricycle, but the mud-guards should be of full width.

The footrests should be within easy reach, and yet so far off as to prevent the revolving pedals knocking the feet or catching in the dress. Instead of footrests, the gear of the machine may be so arranged that the cranks do not rotate when travelling downhill; the feet can then rest on the pedals, and there is no fear of the dress catching on them. But this advantage is more or less counterbalanced by the disadvantage of not being able to retard the machine's onward course by back-pedalling. If free cranks are decided on, particular attention should be given to see that the brake is amply strong and in perfect order. The brake should be as good as, or better than, that fitted to a man's machine, and we believe this point is usually well attended to. The brake handle must be within easy reach of the fingers.

The peak or nose of the saddle should be short and strapped down, or otherwise protected from catching in the dress in mounting.

All parts of the machine where oil is applied should be wiped after lubrication.

If you do not clean your machine yourself, it is best to superintend it when done by a servant.

If the choice of the machine rests with yourself, you had better consult the Editor of *The Cyclist*, Coventry, or, if you prefer it, the writer, who will advise you on knowing your requirements.

Never lend your machine, unless you do not want to use it again. The borrower is almost certain to have an accident, and will probably blame you for it instead of offering to pay for the repairs. Conversely, never borrow a friend's machine, unless you wish to lose the friend.

On giving up a tricycle for a safety bicycle, the lightness and absence of lateral vibration conducing to ease of running will be noticed. On the other hand, the tricycle will be found more convenient in towns, as sudden stoppages can be made without dismounting. So—a safety bicycle in the country and a tricycle in the town.

Riding.—A lady cannot very well learn to ride alone. She will require someone to hold the machine while she mounts and moves along at first. The previous directions for learning to ride should be followed, except that the rider will have to begin in the saddle, as she cannot ride on the step. Steps are not usually fitted on ladies' machines. It is more important to remove the pedals, and even the cranks, as they are liable to catch the dress as well as the feet when the latter are hanging down. The assistant should hold the left handle and head, and put one foot in front of the wheel while the lady mounts. When she is fairly seated, he should take hold of the back of the saddle and one handle and move the machine along at a smart pace. It is much more difficult to

balance when going slowly. As soon as possible the steering should be left to the learner, hold being retained on the saddle only, and then this should be gradually given up.

Mounting.— Stand on the left side of the machine, with the right hand on the right handle and the left on the left. The right pedal should be nearly a quarter of the way past the top, *i.e.*, on the descent. The left foot should be just in front of the left pedal. Place the right foot on the right pedal, and lean the machine a little towards the left. Raise the weight on to the right pedal (this will start the machine) and take your seat at the same time. An easier, though not quite such an elegant, way is to stand, not at one side of the machine, but with the frame between the feet, then put the right foot up backwards on to the pedal and raise yourself into the saddle. Of course someone will require to hold the machine up, at first, but allowing it to move along until you can mount alone. The dismount is just the reverse of the first method. When the left pedal is just beginning to rise, bring the right foot across to the ground in front of the left, leaning the machine slightly to the left; the left foot is taken off when the right one touches the ground. Ladies should cultivate a good ankle action, if only to avoid excessive movement of the knees—which does not look well.

Dress.—We shall not attempt to say much on this subject—our remarks would only be read in a spirit of satirical curiosity if we did. But we would like to say one or two things.

Wear all wool. Wear no corsets—or if you think you must, let them be loose, without bones, and of wool and nothing but wool; they can be had from the Jaeger people. Let your costume be neat, without much elaboration, especially at the back. Wear good sensible shoes (not boots) and dark stockings. The shoes should have eyelet holes, as the hooks used on men's shoes are liable to catch in the dress. Do not use your best gown for cycling, and do not dress up as if you were going for a winter ride instead of for active exercise. The dress is almost sure to get soiled round the edge with oil from the pedals.

The question of the day amongst lady cyclists is no doubt "rational dress." From what we have written above, it will be evident that the ordinary long skirt is a source of danger; it also drags on the knees, and presents a great deal too much surface to the wind. (To prevent a skirt blowing up in the wind, take two Hoven or similar clips, attach them to the two ends of a few inches of elastic, clip one end to the shoe tongue and the other to the inside of the skirt a short distance up from the hem. The clip in the shoe can be released if necessary when walking.) The real rational-dresser will use a costume in principle the same as a man's, whether she wear a skirt or not. The principal objection to the new costume is no doubt its masculine appearance; few men,

considering their own dress, can have the face to call it immodest. A great mistake was made in selecting stiff tailor-made long jackets, men's stiff collars and fronts, and men's ties. Let the dress be as feminine as possible, so that there may be no risk of mistaking the wearer for a boy. We think the skirt should be worn for some time to come, but the sooner it can be shortened so far as to clear the gearing the better. It is a great venture that may have an extremely beneficial result if carried through to the finish, and every care should be taken to guard its inception. The adoption of the rational dress has an indirect advantage, in that it permits its wearer to ride a full diamond man's machine instead of the necessarily unmechanical "drop" frame. A man's way of mounting is not particularly elegant for a woman, but we shall get used to it in due time, after we have first got used to the appearance of the new dress.

CHAPTER XI.

INSTITUTIONS.

CLUBS are mostly useful in tending to improve the rider's pace and his experience of machines and matters cycular in general. The novice should not be in too much of a hurry to join a club, as if the majority of the members are not of his own class, his membership may be rather a drawback than otherwise. A good plan is to get permission from the respective secretaries to attend one or two rides with several different clubs, and then to join the one best suited to one's tastes. The tone of a club is apt to reflect the ideas of those of its members who are favoured with the least amount of sense, and whose notions of manliness are exemplified in seeing how many "pubs" they can stop at, or how quickly they can cover the distance between certain "houses"—quite regardless of the reasonable laws of the land and of the comfort of people in general. Mud-guards, brakes, lamps, and bells, are scorned, the place of the last being filled by a screech—the louder and more hideous the better.

There are two great cycling institutions, "The National Cyclists' Union" and "The Cyclists' Touring Club."

The National Cyclists' Union (usually and hereinafter referred to as the N.C.U.) is the parliament of cyclists. Its objects are, or were—

1. To ensure a fair and equitable administration of justice as regards the rights of cyclists on the public roads.
2. To watch and urge the action of the road authorities with a view to the more efficient supervision and maintenance of the roads throughout the United Kingdom.
3. To watch the course of any legislative proposals in Parliament or elsewhere affecting the interests of the cycling public, and to make such representation on the subject as the occasion may demand.
4. To consider the relations between cyclists and the railway companies, with the view of securing, if possible, some modification of the present tariff for the carriage of bicycles and tricycles, and greater security in their conveyance.
5. To examine the question of bicycle and tricycle racing in general, and to frame definitions and recommended rules on the subject. To arrange for annual race meetings at

which the amateur championships of bicycling and tricycling shall be decided.

Under the first object are included such matters as rights of way, opening of parks to cyclists, obstructions of the highway, gate tolls, rendering legal assistance to cyclists who are assaulted on the highway, and erecting danger-boards on the top of hills which are dangerous to ride down. It has shown its desire for equity by deciding to suspend any rider who takes part in any race on the road, if such race has been publicly announced or advertised, and it deserves the support of every good cyclist for this action, if for no other.

The second object is more in the province of the C.T.C., but the N.C.U. has prevailed upon various local authorities to alter sewer gratings which have been placed lengthwise with the road (in which position they might catch a small-tyred wheel so as to cause a fall) to a position at right angles with it, crossings and tram setts which are at a different level from the road, and other such matters.

Object 3.—The N.C.U. has for some time been recognised in Government circles, and in the days of the old byelaws the Home Office used to consult the N.C.U. before passing these regulations. But the C.T.C. has the credit of getting the present law established, though the N.C.U. was certainly the body which ought to have carried it through. But though ousted in this particular case, this is one of the most important objects of the Union, and it is liberally construed to extend to legal matters in general.

Object 4.—A second and successful attempt to get the railway companies to reduce their charges for conveying cycles by passenger train has recently been made, and this body is largely entitled to the credit. Some of the Southern lines still hold out for the old exorbitant rate.

Object 5.—The N.C.U. authorities have suffered more for their good work in connection with racing than in any other respect. They have been met with shortsighted opposition from racing men for taking the best and only steps which could secure the purity of the sport, and blamed for giving an unfair amount of attention to racing by men who do not go in for that branch of cycling. People do not go to meetings of roadwardens, parliamentary committees, and board meetings of railway directors for the pleasure of doing so, as a rule, but they do go to cycling and athletic meetings, so it is not extraordinary that this branch of the work appears more prominent to the cycling public than it really is. In this connection the Union has issued rules and recommendations for the conduct of all open amateur cycle races, except those on the road, for cyclists who are amateurs according to its definition, which is that:

An amateur is one who has never engaged in, nor assisted in, nor taught any athletic exercise for money, or for any other

remuneration; nor knowingly competed with or against a professional for a prize of any description, or in public (except at a meeting specially sanctioned by the National Cyclists' Union).

To prevent misunderstanding in interpreting the above, the Union draws attention to the following explanation:

A cyclist ceases to be an amateur, and becomes a professional by—

(a) Engaging in cycling, or any other athletic exercise, or personally teaching, training or coaching any other person therein, either as a means of obtaining a livelihood, or for a staked bet, a money prize, or gate money.

(b) Competing with, or pacemaking for, or having pace made by, a professional, or person under sentence of suspension, in public, or for a prize.

(c) Selling, realising upon, or otherwise turning into cash, any prize won by him.

(d) Accepting, directly or indirectly, any remuneration, compensation, or expenses whatever from a cycle manufacturer, agent or other person interested in the trade or sport, for cycle riding.

NOTE.—The Executive has the right to call upon any rider to remove by proof any suspicion of his infringing, or having infringed, the provision of clause *(d)*, and the onus of disproving the charge brought against him shall in such case rest upon the person suspected; who, until he do clear himself to the satisfaction of the Executive, may be suspended.

Cycle manufacturers and agents, as such, are not to be considered as professionals, but are cautioned that to personally teach cycle riding as a means to effect the sale of a machine will be taken as an infringement of clause *(a)*.

The Union has local centres in various parts of Great Britain, and is governed by a Council (composed of representatives from affiliated clubs, and the independent members, the honorary secretaries, chairmen, and delegates of the local centres) and the Executive, which, together with the secretary and treasurer, are elected by the Council. There are various committees for attending to special matters, as records. There is an excellent cycling library, including many good maps, at the offices of the Union, 57, Basinghall Street, London, E.C., which are nominally always open from ten to five o'clock. Anyone may become a member of the Union whose interest in cycling is not measured by a less sum than 5s. per annum, which is the subscription for independent members. Clubs can join *en masse* on advantageous terms. Of course, every cyclist should be a member of the N.C.U., but as it makes little distinction between members and non-members, so long as it acts for the good of the sport, it is not much wonder that this excellent body is not so sound, financially, as it ought to be.

The Cyclists' Touring Club (generally spoken of as the C.T.C.) is an incorporated body, and is one of the largest athletic clubs in existence. The objects for which the club is established are—

1. To promote, assist, and protect the use of bicycles, tricycles, and other similar vehicles on the public roads.
2. To provide legal assistance for the riders of bicycles, tricycles and other similar vehicles in the enforcement of their rights to use the public roads.
3. To promote the comfort and safety of its members while touring on bicycles and tricycles by collecting and furnishing the necessary information for the planning and conduct of cycling tours, and by publishing and supplying to its members road books, maps, periodicals or newspapers, and by providing a suitable uniform and badge for any member at his or her cost, and by arranging for suitable hotel accommodation for its members at their own cost.
4. To amalgamate wholly or partially with any society or institution having objects similar to any of the above objects of the club, or to transfer the property of the club to any such society or institution upon such terms of sale or otherwise as may be desirable.
5. Subject to the provisions of the 21st Section of the Companies' Act 1862, to purchase, take on lease or on exchange, hire or otherwise acquire any real and personal property, and to enter into any contracts or agreements that may be necessary or suitable for carrying out any of the above objects of the club.
6. To collect, receive, and hold funds and property by voluntary contributions, subscriptions, gifts, or legacies for the objects of the club or any of them as the donors may direct.
7. To do all such other lawful things as are incidental or conducive to the attainment of the above objects or any of them.

And they are, in the main, very well carried out.

It will be noticed that they overlap the objects of the N.C.U. to some extent. In other countries one body carries on the work of our two bodies, and even here the men who carry on one are sometimes largely the same as those who conduct the other. The advantages of the two bodies uniting have frequently been demonstrated, but the somewhat vague objection that the time has not come yet has so far succeeded.

A joint body with a five or ten shillings subscription would probably be supported by at least 10,000 comparatively energetic members, and would be able to carry on its operations fully and with success. The C.T.C. is at present hampered by a considerable number

of apathetic individuals who take little or no interest in the club, and only belong to it because it is the thing. They never tour, or, if they do, it were better for the club that they stopped at home. A raised subscription would clear out a large number of these, though, of course, not all.

We take the following particulars from the club publications, but have taken the liberty of toning down a little high-flown language in some cases, and adding a few remarks in others.

Some of the advantages to be derived from membership are—

1. Intending tourists may procure from the various chief consuls full particulars as to the best routes from one part of the country to the other, as well as details of the chief items of interest.

2. The assistance and guidance of the local consul can be counted upon in every place of importance.

3. The benefit of special and reduced tariffs can always be obtained at certain hotels in nearly every town and village in the United Kingdom, as well as in the majority of the countries in Continental Europe.

4. Companions of kindred tastes can be secured by the free advertisement which is given to the member's requirements in the club *Gazette*.

5. The member may purchase the official roadbooks and handbooks of the club. The former comprise a complete continental route book in three volumes, and a British and Irish roadbook in process of compilation. One of the handbooks applies to the United Kingdom; the other to the Continent, the United States, the Colonies, etc.

6. The member has the right of purchasing and wearing the uniform of the club and the badge. The former is procurable of any of the official tailors, but the badge is procurable of the secretary only.

7. He is supplied *gratis* month by month with a copy of the club *Gazette*, a magazine of from twenty to forty pages, containing full details of the club's progress, reports of the meetings of the Council and the membership, narratives of tours planned and undertaken, critical articles on the construction and reviews of machines, together with much other matter of interest.

Apart from these material and personal advantages the member has the satisfaction of knowing that he is aiding by his alliance therewith a body which is ever on the alert to promote the best interests of cyclists, and which has already been instrumental in (*a*) reducing the charges for the transit of cycles by passenger train; (*b*) removing unreasonable restrictions as to the use of the public parks by wheelmen; (*c*) abolishing the conflicting and anomalous county and borough byelaws, and substituting therefor a statute

law declaring cycles to be carriages within the meaning of the Highway Acts; (*d*) publishing and circulating with good effect pamphlets upon economical road maintenance.

The liability of each member is, by the Memorandum and Articles of Association, limited to the sum of ten shillings, which amount will only be called for in the event of the club becoming involved in financial difficulties.

Every member should certainly purchase the handbook, which is issued annually at 1s. to members only.

The club is strictly confined to cyclists who are amateurs according to the definition of the N.C.U. Cyclists abroad are accepted as amateurs according to the rules in force in their own country, provided they have not at any time been guilty of breaches of the amateur laws of any country when riding in such country. Ladies are eligible as well as gentlemen. The entrance fee is 1s. The subscription is 3s. 6d. per annum, and is renewable by each member on the 1st of January in each year irrespective of the date of his joining the club. The candidate for membership should obtain an application form from the secretary, 139, Fleet Street, London, E.C., and return it to him filled up and with the needful 4s. 6d. before the 20th of one month, and the name of the aspirant will be included in the list of candidates published in the next *Monthly Gazette*.

The uniform is to some extent a misnomer, as, provided the suit be made of the club cloth, the member is at liberty to use his own taste pretty freely as to shape and style. The badge is decidedly artistic, and, though it bears a strong resemblance to that of the League of American Wheelmen, is nevertheless a well-thought-out affair.

The Continental Road Book reflects great credit on its compiler, Mr. S. A. Stead, one of those hard-working, good-natured men who are the very mainstay of such institutions as the C.T.C. The British Route Book, as exemplified by the first volume, stands alone in its own line, and is ably supplemented by some excellent descriptions of the items of interest along the various routes appearing in the *Gazette*.

The club has given its effective attention to the opening of parks, assaults, danger-boards, railway rates for conveying cycles, laws and byelaws affecting cyclists and their machines, road maintenance, etc.

Several enterprising tradesmen offer specially low prices to the members of the C.T.C.

The secretary, Mr. E. R. Shipton, has done wonders for the club, and though he may appear to some a little high-handed in various little matters, he can readily be forgiven this when his devotion to the club and the somewhat ungentlemanly and senseless attacks he is subjected to are considered.

A cyclist who joins the Touring Club, and tours accordingly, can hardly fail to save his subscription over and over again.

M

CHAPTER XII.

A FEW POINTS OF LAW.

SOME makers give a written guarantee with their machines, but if they do not they are still liable if the machine bought from them causes an accident to the purchaser, owing to some defect which, if they did not actually know existed, they could have easily found on making proper examination before sending out. But the rider will greatly jeopardise his chance of getting damages if he helps to bring about the accident himself. If the maker stipulates that he will not be liable for defects, and the purchaser accepts the machine on these conditions, the latter will, of course, be bound by the stipulation.

If the breakage is really the maker's fault, he will, if a respectable man, repair the machine free, and perhaps pay part, or all, of the carriage, but any attempt to make him bear the cost of getting home from the scene of the fray or similar expense will probably be fruitless.

The case of an agent letting out a machine which he knows to be defective or dangerous is similar.

Surveyors are usually liable for sins of commission, but not for sins of omission.

Highway authorities who leave obstructions on the road at night without taking proper care to prevent their being dangerous, are liable to a penalty of £5.

Actions against authorities should be brought promptly, if at all, as there is a time limit of three months from the date of the accident if they be brought under the Highways Act, and six months if under the Public Health Act 1875, and a notice must be given, expiring at least a month before bringing the action.

By Section 85 of the Local Government Act (England and Wales) 1888, all the old byelaws, etc., relating to bicycles, were repealed, and cycles of all descriptions are declared to be carriages, under the Highway Acts, with the following additional regulations, to be observed by any person or persons riding or being upon such carriage.

(a) During the period between one hour after sunset and one hour before sunrise, every person riding or being upon such carriage shall carry attached to the

carriage a lamp, which shall be so constructed and placed as to exhibit a light in the direction in which he is proceeding, and so lighted, and kept lighted, as to afford adequate means of signalling the approach or position of the carriage.

(b) Upon overtaking any cart or carriage, or any horse, mule, or other beast of burden, or any foot-passenger, being on or proceeding along the carriageway, every such person shall, within a reasonable distance from and before passing such cart or carriage, horse, mule, or other beast of burden, or such foot-passenger, by sounding a bell or whistle, or otherwise, give audible and sufficient warning of the approach of the carriage.

Any person summarily convicted of offending against the regulations made by this section shall, for each and every such offence, forfeit and pay any sum not exceeding forty shillings.

It will be observed that these regulations apply to England and Wales only, and are only in force while the person is riding upon his machine, so that pushing one's steed along without a light, during the time when a lighted lamp is a necessary accompaniment to riding, is not now illegal.

The second clause is somewhat vague as to whether the audible and sufficient warning may be merely vocal or whether an inanimate "organ" must be used. The common-sense view is that shouting is enough, but there is an awkward principle in the law, called *ejusdem generis*, by which such words as "otherwise" are interpreted solely in relation to the catalogue which precedes it, so that it will be safest only to shout when there is something wrong with the bell or whistle.

Cycles are usually liable to pay toll where other vehicles have to do so.

As a cycle is a carriage, its rider can be convicted of furious driving if he proceed at a dangerous rate.

Foot-passengers have a right to walk in the road if they prefer to do so, even on the wrong side, and even if this were not the case the cyclist would not be at liberty to run them down without rendering himself liable to an action.

The wrongful action of one person does not free the other from the responsibility of taking all reasonable care. Extra watchfulness and control of machine must be exercised when riding on the wrong side of the road and over crossings for foot-passengers.

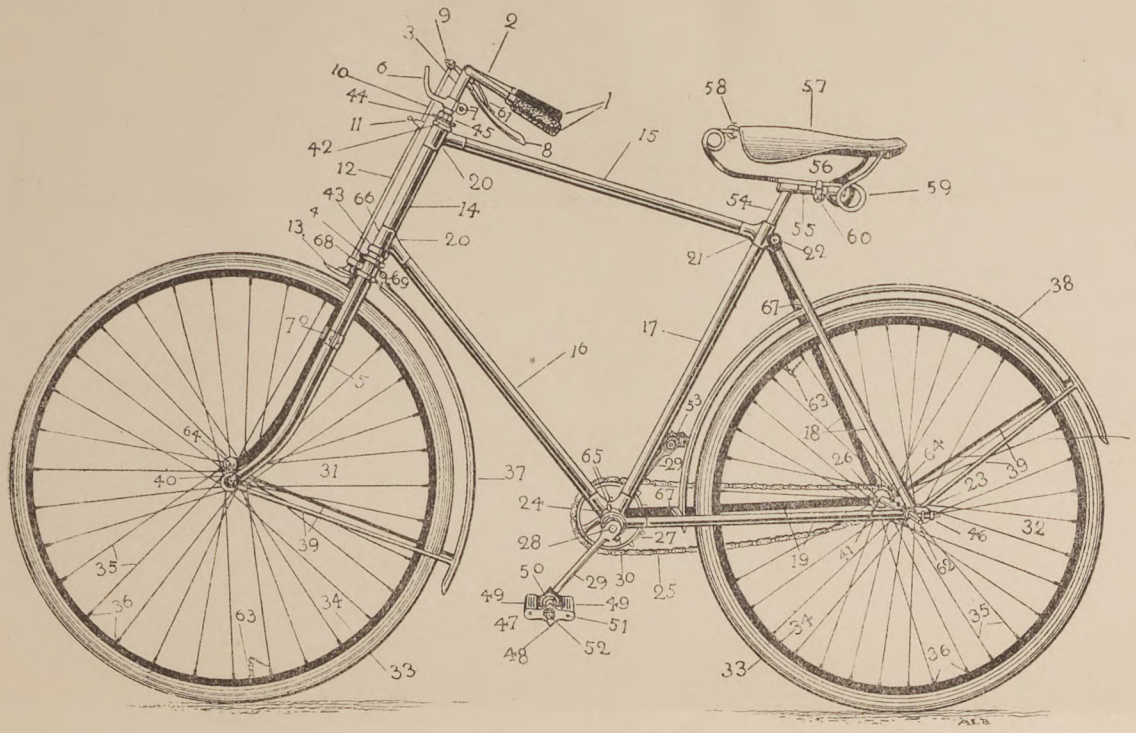
A race being a joint affair, either of the competitors may be proceeded against by a party run down by one of them.

Any person who drives a cycle or any other carriage so negligently as to injure another person renders himself liable for

the damage done. In such and similar cases the injured party should himself note in writing, and get any witnesses there may be present to confirm his notes by adding their names and addresses, the time of the accident, whether dark or light, the situation of the wheel tracks before the accident, the position of the parties and vehicles, etc., after it, whether he was sounding a bell, showing a light, or otherwise making known his presence. A photograph of the situation taken as soon as possible is valuable, especially in cases of obstruction. We may here give a hint to witnesses, when in court, to refer to the sides of the road as north and south, or east and west, as the case may be, and not as right and left—either side is right or left according to the way you look at it, and to thus name them generally confuses instead of distinguishing.

An innkeeper is obliged to place what accommodation he has at the disposal of any respectable person who can pay for it, and provided he be not suffering from an infectious disease. He will be liable if his guest's machine be stolen or damaged while under his protection, though he will not, except under certain conditions, be liable to pay more than £30. On the other hand, if the guest fail to pay up, the landlord may retain his machine and luggage (but not the guest himself) until paid, or after six weeks may sell them, and hand over any surplus—the sale must be advertised a month beforehand in a London and local paper. The landlord's liability must not tempt the guest to be careless, or he (the latter) may fail to recover damages.

By the Betting Houses Act 1853, and the very strained decisions given under it, a bookmaker must keep walking about unless he wishes to render himself liable to prosecution. Further than this, if, when attending sports, he refuse to stop betting when required to do so, the promoters may make him a trespasser by revoking the license they gave him on accepting his admission money, and turn him out—by force if necessary.



List of parts to which numbers on block refer.

1. Handles or grips.
2. Handle-bar.
3. Handle-bar stem or stalk.
4. Fork-crown.
5. Front fork.
6. Lamp bracket.
7. Handle-bar cramp or clip.
8. Brake lever.
9. Brake joint and screw.
10. Brake plunger rod.
11. Brake cramp and screw.
12. Brake tube.
13. Brake spoon.
14. Socket tube. } Rear frame.
15. Upper backbone. } Rear frame.
16. Lower backbone. } Rear frame.
17. Diagonal or down tube. } Rear frame.
18. Back fork. } Rear frame.
19. Back stays. } Rear frame.
20. Head lugs or joints.
21. Saddle-pillar cramp or lug.
22. Saddle-pillar bolt and nut.
23. Back fork end.
24. Crank-axle bracket or bottom bracket.
25. Chain (Humber or block).
26. Hub or upper chain wheel.
27. Lower, bottom, or crank-axle chain wheel or sprocket wheel.
28. Crank axle, shaft, or spindle.
29. Cranks.
30. Crank cotter.
31. Front or steering wheel.
32. Rear or driving wheel.
33. Tyres (pneumatics).
34. Rims or felloes.
35. Spokes (tangent or laced).
36. Nipples.
37. Front mud-guard.
38. Rear mud-guard.
39. Mud-guard stays.
40. Front hub.
41. Back hub.
42. Top head cup.
43. Bottom head cup.
44. Adjusting cone (head).
45. Lock nut.
46. Chain adjusters.
47. Pedals (rubber).
48. Side plates and guides or points.
49. Pedal bars, blocks, or treads.
50. Pedal spindle and centre tubes.
51. Block pin.
52. Small pedal nut.
53. Large pedal nut.
54. Saddle or seat or Γ pin, pillar, or post.
55. Arm of ditto.
56. Saddle.
57. Saddle leather or top.
58. Saddle tension.
59. Saddle spring.
60. Saddle clip or boss.
61. Brake spring.
62. Step.
63. Valves.
64. Hub lubricators.
65. Bracket lubricators.
66. Head lubricator.
67. Bridges.
68. Brake guide.
69. Mud-guard clip.
70. Footrests.

THE "BANTAM."

STANDARD PATTERN.

ROAD RACER.

We assert that, taken all round, the "Bantam" is a better machine than the Chain Safety. The following are its advantages:

1. It is very fast, and a capital hill-climber.
2. It is mounted with the greatest ease, no step being fitted or required.
3. It is very light, viz, Standard Pattern 28lbs., and Road Racer, 22lbs.
4. It is very comfortable, owing to the rider's position midway between the wheels, which greatly reduces vibration.
5. The relative positions of rider, handles, saddle, and pedals are also much more natural and comfortable than can be secured on a rear-driver without objectionable modifications of frame, &c.
6. It is remarkably compact, measuring only 4ft. 7in. over all; whereas a Chain Safety measures 6ft. 2in.
7. It is very cleanly, mudguards effectually protecting the rider, so that it can be used in any state of the road.
8. The gear gives no trouble, and will outwear half-a-dozen chains.

Send P.C., with address, for Price List of above and Crypto F.D., Crypto Safety with and without Collier Two-speed Gear, &c.

CRYPTO WORKS CO., LTD.,

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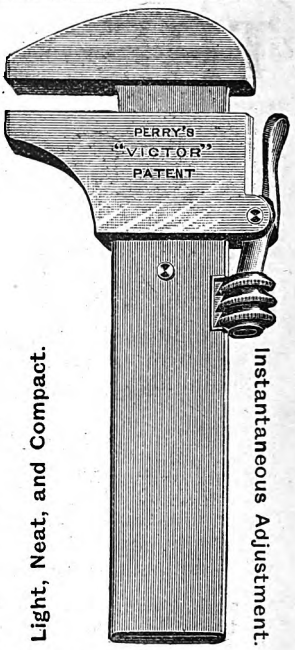
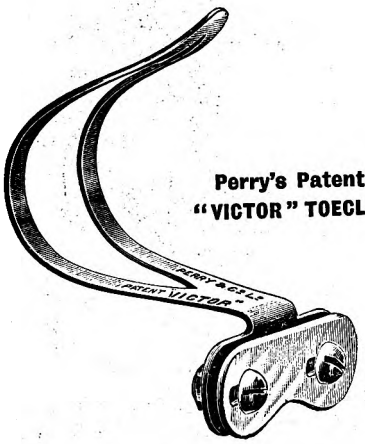
PERRY & CO., Limited,

BIRMINGHAM.



Instantaneous Adjustment.

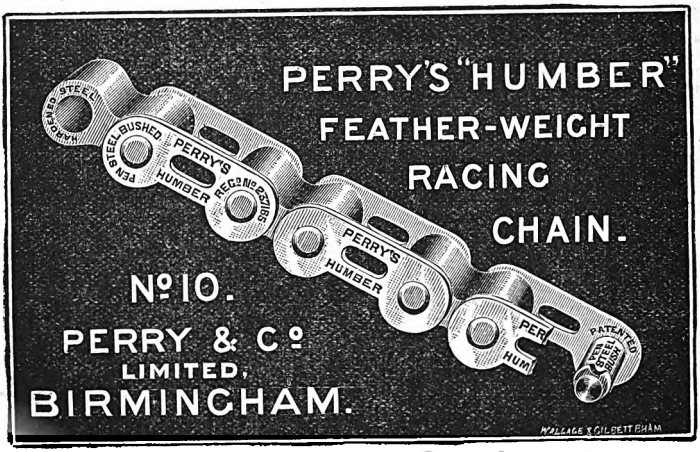
Light, Neat, and Compact.



Perry's Patent
"VICTOR" TOECLIP.

PERRY'S WORLD-RENOWNED CHAINS

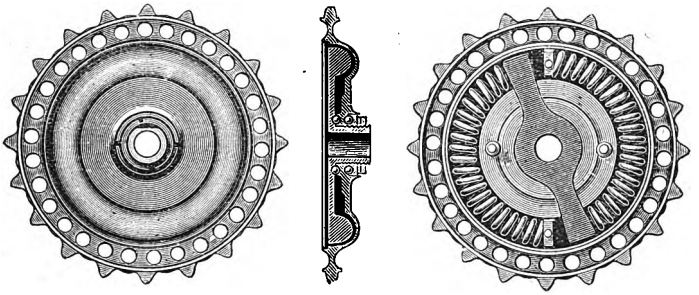
Used on "Humbers," "Raleighs," "Triumphs," &c., &c.



Used by Zimmerman, Wheeler, Harris, Lehr, Henie, &c., &c.

Cycle Spring Speed Chain-wheel.

THIS invention consists of the introduction of Springs in the Chain-wheel for the purpose of, first, *relieving the rider of the concentrated resistance of the machine.* Second, *increasing the power at the weakest points of the circles formed by the revolutions of the pedal cranks.* Third, *removal of pedal vibration.*



The above illustration shows (1) the exterior appearance of the Chain-wheel; (2) a sectional cutting through the wheel with the ball bearings; (3) the interior of the spring chamber with springs slightly in compression at the commencement of the downward stroke.

It was placed on the market about the middle of the riding season 1894, and has since been exhaustively tested by experienced Cyclists over all kinds and conditions of roads.

The verdict has been universal in its favour, as the opinions of the Press and Testimonials (sent post free on application) conclusively prove.

Realising, however, as we do, the difficulty of bringing a new Invention into general use, no matter how good its merits may be, we have, in order to afford the Cycling public an opportunity of fully appreciating the Spring Chain-wheel, made arrangements to supply it, either direct or through any Manufacturer or Agent, for

ONE MONTH'S FREE TRIAL.

If not approved, on return of the wheel, the amount paid will be refunded.

The Spring Chain-wheel does not alter the frame or bottom bracket, and is therefore capable of being fitted to any machine, old or new.

The Wheel is manufactured for us by the Cycle Components Mfg. Co., Ltd., and can be obtained at any of the Company's Depots. It is also sold at all the Depots of the John Griffiths Cycle Corporation, Ltd., in London, Edinburgh, Dublin, Liverpool, Manchester, Leeds, Glasgow, Belfast, Coventry, Bristol, Brussels, Newcastle-on-Tyne, Antwerp, New York, Toronto, Melbourne, etc. And by all the leading Cycle Agents and Dealers in the United Kingdom, Continent, and Australasia.

For terms and full particulars, apply

THE CYCLE SPRING CHAIN-WHEEL SYNDICATE, LTD.,

54, Holborn Viaduct, LONDON, E.C.

NORTH BRITISH RUBBER CO., LTD.,

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