bottom of the upper, admits the air in an upward direction to the ceiling above the heads of the occupants. Holes bored in a perpendicular direction in the bottom of the upper sash, louvered panes to replace one of the squares of glass, an arrangement for allowing one of the squares of glass to fall inwards upon its lower border and providing it with side cheeks, or a double pane of glass in one square open at the bottom outside and at the top inside—all effect the same purpose and are simple and inexpensive contrivances. Wall inlet ventilators, as the Sherringham valve and Tobin's tubes, are constructed on the same principles, fresh air, which in towns may be filtered through muslin or cotton wool, or made to impinge upon a tray containing water so as to deposit its sooty particles, being admitted at a height of about 6 feet from the floor and directed upwards towards the ceiling. The usual outlet for vitiated air is the chimney-flue, and this for an ordinary medium-sized sitting-room, with a fire burning, is sufficient for three or four people, provided no gas is alight, or the gas lamp has its own special ventilating arrangements. With an ordinary fire, from 10,000 to 15,000 cubic feet of air are drawn up the chimney in an hour. Valves placed so as to open into the flue near the ceiling are sometimes used as outlets for foul air, such are Neil Arnott's and Boyle's valves, which permit air to pass into the flue, but prevent its return; the only objections to their use are that they occasionally permit the reflux of smoke into the room, and their movements backwards and forwards cause a slight clicking noise. In all new buildings where efficient ventilation is desired, it would be preferable to construct a shaft at one side of, or surrounding the chimney-flue, with an inlet near the ceiling of the room and the outlet at the level of the chimney top, so that the air escaping from the room would have its temperature kept up by contact with the chimney, thus aiding the updraught, whilst the risk of reflux of smoke would be avoided. In all new domestic buildings a very great improvement might be effected by providing for the warming of the air before its entry into the apartments. The window and wall inlet ventilators just described are occasionally productive of draughts in cold weather, so that it is more usual to find them closed or stopped up than in action, or else admitting a very insufficient supply of air; but if the air be warmed before admittance to an agreeable temperature a very large amount may be allowed to enter without the fact being known to the occupants. The ventilating stove invented by Captain Galton, the Manchester school grate, and other forms effect this purpose in the following manner: Behind the grate, which is lined with fire-clay, is a chamber into which fresh air is admitted by a pipe from the outside. The air, here warmed, is admitted into the room by a pipe opening at about the level of the chimney breast and guarded by a grating which can be opened or closed as found convenient. In the Manchester school grate the warmed air is admitted by vertical pipes, like Tobin's tubes, opening on a level with the chimney-piece. The danger in these grates is that cracks may be formed by the heat of the fire in the joints or in the cast-iron plates which surround the air chamber, and thus direct communication be established between the grate and air chamber with the result of deleterious products of combustion being admitted into the air of the room. When the stove is lined with fire-clay there is no danger of the air in the chamber being overheated, producing charring of the organic matter in the air and an offensive smell, which is so often noticed around stoves where this precaution has not been taken. In Mr. Saxon Snell's ventilating thermhydric stove the fresh air is warmed by passing over hot water pipes in the stove before entrance into the room, the hot water being derived from a small boiler at the back of the grate. The temperature of the water is not high enough to overheat the air.

Gas is being gradually introduced for heating purposes, and with a reduction in its price we may look forward to its more extended use. There are several ventilating gas stoves by which air is admitted into a room warmed after passing through the stove. It is important to regulate the heat carefully so as not to overheat the stove and the air which is passing through. In churches and other public buildings air is usually warmed before entry by passing over hot water pipes which circulate around the building under the floor. In all large buildings the combustion of gas may be made a very effective means of getting rid of foul air. It has been found by experiment that the combustion of one cubic foot of coal gas causes the discharge of 1000 cubic feet of air. In theatres where gas, although being gradually replaced by the electric light, is still much used, the extraction of foul air from the roof of the building by the sunlight burners presents no difficulty. The difficulty experienced is the introduction of fresh air from below without causing draughts. In private houses the use of an extraction shaft over the gas chandelier or a Benham's ventilating globe light, or a Mackinnel's ventilator greatly aid the extraction of foul air from the ceiling, whilst the two latter are also useful in providing inlets for fresh air which enters slightly warmed near the ceiling, and is then directed horizontally by flanges so as to be distributed over the room. Outlets in the ceiling of a room may become inlets when a strong fire is burning, as the draught up the chimney will overbalance the extractive power of the gas and cause all other openings into the room to be inlets. We may here mention an ingenious method for warming the air admitted by Tobin's tubes into a room: a row of small Bunsen burners encircles the tube at its foot, and the products of combustion are conveyed away by a tube which surrounds the Tobin and opens into the outer air.

In large public buildings, where expense is no object, a combined method of ventilation by propulsion and extraction presents many advantages. The amount of air admitted can be easily regulated, warmed, cooled, or moistened, and freed from impurities by filtration, and enormous volumes are capable of being so supplied by propulsion and removed by the extractive powers of a furnace. In the Houses of Parliament where this system is in operation, air is propelled by rotatory fans along conduits to the basement, where it is warmed in winter by passing over steam pipes, and then passes upwards through shafts into the space beneath the grated floor of the House. The heat can be regulated by covering the steam pipes with woollen cloths, and in summer the entering air can be sprayed with water or cooled by passing over ice in the conduits. The vitiated air in the House passes through a perforated glass ceiling in the roof, and is then conducted by a shaft to the basement of the Clock Tower, where it passes into the flue of a large furnace.

The introduction of electricity for lighting and of gas for heating purposes will, in the case of both public and private buildings, considerably modify the methods of ventilation now most generally used.

CYCLES

THE Institute of Mechanical Engineers held a general meeting in the Corn Exchange, Coventry, on the afternoon of Wednesday, October 28, Mr. Jeremiah Head, President, in the chair, when the Secretary read a paper by Mr. R. E. Phillips, of London, "On the Construction of Modern Cycles," of which an abstract follows:—

The cycle industry in this country has grown with such rapidity and has already assumed proportions of such magnitude as to lead the author to hope that the present paper may prove of some interest to the Institution. It would not be possible within any reasonable limits to do justice to all matters connected with cycles; and he therefore purposes dealing only with their general construction, pointing out the underlying principles, and describing the various types at present made in order to show how far these principles have been carried out, and what degree of perfection has already been attained.

Power.—The experiments of Messrs. S. J. and G. S. Stoney show that with a lever action bicycle the power necessary to produce speeds of from six to fourteen miles an hour on an average road ranges from one-seventh to one-third of a horse-power; but the author thinks that less than this would be necessary with an ordinary rotary action bicycle.

Bicycle.—Gavin Dalzell, a cooper of Lesmahagow, in Lanarkshire, in 1836 first fixed a pair of cranks to one of the wheels of a hobby horse, and may therefore be considered the inventor of the bicycle. In 1868, Mr. Cowper, a past President of the Institution, specified, amongst other things, suspension wheels with wire spokes, hollow felloes, rubber tyres, and anti-friction roller bearings, and may thus be considered the inventor of the suspension wheel. Without these features or some modifications of them no cycle at the present day is satisfactory.

Tricycle.—Although the tricycle was invented contemporaneously with the bicycle it did not attract much attention until six years later.

Statistics.—Over one thousand patents were applied for for improvements relating to velocipedes before the end of 1883, and during 1884 (under the new Act) 637 applications were filed. There are 170 firms who devote themselves exclusively to cycle making, and turn out over 500 different machines. The trade employs 3000 men in Coventry and at least 5000 in the United Kingdom. About 40,000 machines are sold annually, of the gross value of about 800,000*l.*

Performances.—The following "records" are given:—

On a Racing Path

Distance run, miles	Duration of race, hours		Mean speed, miles per hour	
	Bicycle	Tricycle	Bicycle	Tricycle
1	0·044	0·050	22·6	20·0
5	0·238	0·272	21·0	18·4
10	0·489	0·543	20·5	18·4
20	0·985	1·145	20·3	17·5
25	1·278	1·442	19·6	17·3
50	2·733	3·054	18·3	16·4
100	5·835	6·726	17·1	14·9

On Ordinary Roads

Journey	Bicycle		Tricycle	
	Hours	Days	Hours	Days
Distance of 100 miles	7·19	—	7·58	—
Land's End to John O'Groat's (about 900 miles)	160·17 =	6·67	197·33 =	8·22
Land's End to John O'Groat's and back, and thence to London, about 2050 miles	456 =	19		
Greatest distance in 24 hours	266¼ miles		231½ miles	
Mean speed for the 24 hours, miles per hour	11·1 ,,		9·6 ,,	

From these performances it appears that the bicycle has an advantage of from 2 to 2½ miles per hour.

Classification—

Bicycles

1. Bicycles of the ordinary type.
2. Safety Bicycles, which may be subdivided into—
   a. Dwarf bicycles with geared rotary action.
   b. Dwarf bicycles with lever action.
   c. Safety bicycles with steering wheel in front.
3. Tandem bicycles.
4. Otto bicycle.

Tricycles

1. Single drivers, which may be subdivided into—
   a. Rear steerers.
   b. Coventry rotary, side steerer.
   c. Double front steerers.
2. Double drivers, which may be subdivided into—
   a. Those driving by clutch action.
   b. Those driving by differential gear.
3. Humber tricycles.
4. Hand power tricycles.
5. Sociables.
6. Tandems.
7. Carriers.

All these may be again subdivided as driven by "rotary" or "lever" action.

BICYCLES

Ordinary Bicycles.—The ordinary type of bicycle is so familiar that it need not be referred to at any length, especially as the details of construction will be dealt with later on. Being supported on only two points it is unstable, so it tends to fall one way or the other. Equilibrium is maintained by steering to that side to which it tends to fall. As the rider is seated only a little behind the centre of the driving wheel he is able by his feet alone to control the steering and so maintain his balance. When working the rider must counteract the thrust of his feet by pulling at the handle bar with his arms alternately on either side. It is this combined action which renders the riding of a bicycle so difficult to learn. The bicycle cannot be driven along a perfectly straight line, hence anything that interferes with the freedom of steering, as the groove of a tram line, makes the balance impossible.

Weight.—The weight of an ordinary roadster bicycle varies from as many pounds as its driving wheel is inches in diameter down to from 15 to 20 lbs. less than this. A racing bicycle weighs from 18 to 25 lbs., according to size. The proportionate weights of the several parts were given.

Vibration, which is the chief source of discomfort in most cycles, is mitigated by the use of india-rubber cushions between the wheel bearings and the forks, between the backbone and the spring, and between the head and the handle.

A spring fork was shown which serves to diminish the vibration produced by the small wheel of a machine.

Dwarf Bicycles with Geared Rotary Action.—Machines of this class have a smaller driving wheel connected with the pedals by chains and chain wheels. This makes it possible to "gear up" the driving wheel so as to be equivalent to one of any size. The high gearing thus introduced is the cause, in the author's opinion, of their ease of propulsion and speed.

Dwarf Bicycles with Lever Action.—The "Facile" bicycle is a prominent example of this type of machine. The motion of the feet is simply reciprocating, and as the wheel is not "geared up" the feet keep time with the driving wheel.

The 'Xtraordinary is another example of a lever action machine. In this machine the fork rakes back to a great extent so that the rider is far behind the centre of the driving wheel, but the pedal levers bring the pedals to a convenient position. Their path is oval. These machines are made of the full size.

Safety Bicycles with Steering Wheel in Front.—In machines of this class the rider sits well over the driving wheel, which is behind. A single chain is sufficient, as in this kind of machine there is a "through" crank-axle. In a modification of this pattern a divided crank-axle is employed, which allows the rider to be still more over the driving wheel. The frame, moreover, is made capable of swinging and of being locked in various positions, so that the rider can place himself in the best position under all conditions.

Machines of this type are rather sensitive in the steering, but as automatic contrivances to keep the steering wheel running straight are apt to interfere with that freedom which is necessary for the balance, such devices are not altogether desirable.

In these machines the feet cannot be used to control the steering as in an ordinary bicycle, but the author of the paper has contrived a means for effecting this. On the centre of the crank axle is a spherical boss, on which can swivel, but not turn freely in all directions, a large double hollow chain wheel kept parallel to the driving wheel by two idle rollers. As a matter of fact the crank axle swivels within this chain wheel and the brackets which support it being rigidly connected with the handle bar serve to steer the machine.

Tandem Bicycles.—At present there are only two makes of tandem bicycle, each invented by Mr. Rucker. The earlier one is constructed of two ordinary bicycle driving wheels complete in their forks, which are then connected by a backbone containing an axial joint. Each rider drives, steers, and balances on his own wheel independently of the other, but of course the rear must follow within a foot or so the path of the one in front. Although this machine is very fast, lighter than two ordinary bicycles, and almost entirely free from vibrations, there is an element of danger about it that militates against its general use, inasmuch as it demands to a certain extent a unity of thought and action on the part of both riders.

A very satisfactory tandem has been arranged by the author, a modification of this, in which the rear wheel is replaced by the driving wheels of an ordinary Humber tricycle, the connecting bar of course being modified to suit the altered conditions. The later tandem bicycle eclipses the earlier; it is probably the fastest machine in existence. It is constructed on the lines of a dwarf geared bicycle. The seat for the front rider is mounted immediately over the centre of the driving wheel, while the rear rider who alone steers and manages the machine is about midway between the two wheels. Divided pedal axes are mounted fore and aft of the centre of the driving wheel. The weight of this bicycle is only 55 lbs.; it is therefore the lightest machine yet made to carry two riders.

Otto Bicycle.—This peculiar machine, which is due to the brother of the inventor of the gas engine known by the same name, is almost more nearly allied to a tricycle than to a bicycle proper, but as it has only two wheels and consequently requires the balance to be still maintained by the rider, it is rightly called a bicycle. The wheels are the same size, and are here mounted loose on the same axle, parallel to each other and both of them are drivers. The rider sits between them and works a continuous pedal crank-axle, the position of which when he is seated is below and slightly in front of the axle carrying the driving wheels. The crank axle is connected with the driving wheels by endless steel bands passing round plain pulleys on the ends of the crank-axle and on each wheel. The bands are kept taut by tightening springs, and the machine is steered by slacking one or other of them, which causes the corresponding driving wheel to lose motion, and therefore the other wheel runs round it. If a very sharp turn has to be made suddenly, a brake is applied to one wheel at the same time that its driving band is slackened, which causes the machine to turn round in a circle upon that wheel as a centre. This machine having no small wheel fore or aft, the rider, while steady sideways, has to balance himself in the direction of his motion, which he is enabled to do through the medium of the pedal crank axle; by pressing on the forward pedal, if he is falling forwards, he throws his weight backwards and conversely by pressing on the rear pedal he throws his weight forwards. To preserve him from actually capsizing backwards a safety tail projects behind the seat, which will bear on the ground whenever the seat is tipped too far back.

Among the many beautiful features presented by this machine the best seem to be: (1) the balance whereby the rider is always in the best position to utilise his strength and weight notwithstanding the various gradients; (2) the nicety by which it can be steered; (3) its tendency to run in a straight line without any effort on the part of the rider; (4) its freedom from vibration; (5) the circumstance that it makes only two tracks.

TRICYCLES

The tricycle presents far greater difficulties than the bicycle. It is necessary that each wheel shall be free to move in its own direction independently of the united action of the other two. For running in a straight line all three wheels must be parallel; whilst for running round a curve, one or more of the wheels must be turned until the centre lines of the axles intersect in plane, their point of intersection being the centre of the path described. Besides being independent in direction of running, each wheel must also be capable of revolving at a greater or less speed than the others. It is also essential that only so much of the rider's weight shall be borne by the steering wheel or wheels as is necessary to ensure their proper action. Owing to the variety of ways in which these principles can be carried out practically, it is easy to account for the variety of tricycles constructed.

Single-driving Tricycle.—The simplest form of tricycle is that with only one driving wheel, either or both of the others being used for steering. The single driving rear-steerer is now practically obsolete.

Coventry Rotary Tricycle.—Another single driver, known as the "Coventry rotary," has the large driving-wheel on one side, and two small steering wheels on the opposite side, arranged to turn together in contrary directions for steering. The double steering counteracts the evil of one-sided driving. Though one of the first machines introduced it is still largely in use, its advantages being that it is simple, it makes only two tracks, and it is narrow enough to pass through an ordinary doorway; this, however, diminishes its natural stability.

Front Steering Tricycle.—A single driving machine of this class exists which is steered by the two front wheels, and driven by the rear wheel, but there is not sufficient weight on the driving wheel.

Double-driving Tricycles.—In these the two driving wheels are always placed parallel and opposite to one another, with the steering wheel in front or behind, and generally central. It is sometimes placed on one side when the tricycle makes only two tracks. There are two methods of double-driving: firstly, by clutch-action; secondly, by differential or balance gear.

Double-driving by Clutch Action.—In this plan the two driving wheels are locked to their axle only when the machine is being driven forwards in a straight line, but in running round a curve the outer wheel overruns the clutch and the inner wheel alone drives. In the Bourdon Clutch, which is most generally used, a disk has its edge cut away so as to form three or more inclined planes. In each of the spaces between these recesses and an outer ring is a hard steel roller, which jams when the clutch drives the wheel, but which does not hinder the wheel from running ahead of the clutch.

A clutch machine cannot, without extra gearing, be driven backwards, nor can it be retarded except by the action of the brake. On the other hand the free pedal is a convenience. Various attempts have been made to construct a clutch which shall drive either way, but hitherto without success, in consequence of the loss of time between the forward and the backward grip. The author of the paper is now at work on this problem.

Double Driving by Differential or Balance-Gear.—This other mode of double driving, so called because the power is divided or balanced between the two driving wheels, depends on the action of an epicyclic train, in which the two primary wheels are connected with the driving wheels of the tricycle, while the arm or train which connects them is driven. The simplest form invented by Starley consists of three bevel wheels. Here the arm or axis of the middle one being carried round, drives the other two and hence the driving wheels, which nevertheless can move independently. Other gears were spoken of, and a figure of the Sparkbrook gear given.

Each kind of driving has its advantages. When running straight the clutch system drives each wheel, and when one wheel meets with more resistance than the other, as much extra force as is necessary is supplied to it, so that obstacles are surmounted with less chance of swerving. In going round a corner only the inner wheel is driven.

With balance-gear the same force is applied to each wheel, whether the path is straight or curved.

A rear steering tricycle driven by clutch action, a rear steerer driven by differential gear, and a front steerer driven by differential gear were exhibited.

Humber Tricycle.—Among tricycles driven by differential gear, the Humber is quite peculiar. The rider sits astride a back bone carrying a trailing wheel, and steers by turning the axle of the two driving wheels by means of a handle bar. The differential gear is essential to a machine of this type, as it does not interfere with the steering, while it is at all times perfectly double driving.

A curious machine—a modification of the Humber—was shown, in which all three wheels take part in the steering, but of entirely novel and elegant design.

As with bicycles, so with tricycles, the power may be applied in one of two ways: either by rotary action or by lever action. For changing the power, levers are more convenient, but they do not compare with rotary action in point of speed.

Omnicycle.—One of the most successful lever machines is the omnicycle, a machine in which the pedals are connected with the circumference of a segment by means of a leather strap. When one pedal descends it causes the segment on the other side to return and raise the pedal on that side. The segments can be expanded to various extents, so that the power is applied with various degrees of leverage according to the work to be done.

Direct-Action Tricycle.—The simplest rotary tricycle has no chain or connecting mechanism; the pedals are on the main axle, which is cranked. This gives rise to the insuperable objection of instability as the rider is necessarily perched up high. By the use of hanging pedals a few inches are gained.

Transmission of Driving-power—Reverting to the ordinary type of tricycle in which the power is applied to a crank axle and transmitted thence to the main axle, there are three plans commonly in use—(1) by chains or bands: (2) by gear wheels; (3) by cranks and coupling-rods.

Driving-Chains. These are the most popular means of transmitting power, as they offer the greatest facilities for gearing up or down. The Morgan and the Abingdon chain were figured and described.

Driving-Bands.—Steel bands, plain or perforated, have been used with some success. The Otto bicycle is the only machine in which plain bands are used for driving. The power spent in continuous flexure of the bands outweighs, in the author's opinion, any other advantages they may possess.

Gear-Wheels.—In this system an intermediate wheel gears with those on each axle; but as the wear cannot be taken up without destroying the pitch, the plan is hardly satisfactory. Rollers are occasionally fitted over the teeth of the intermediate wheel.

Coupling-Rods.—Coupling-rods are used on a few machines; with the exception that they will not permit of gearing up or down and that they cannot be used with differential gear, they give very good results.

Another method due to Mr. Boys, in which eccentrics and steel bands are employed, was also referred to.

(*To be continued.*)

NOTES

Dr. Asa Gray was presented, on November 18, being the seventy-fifth anniversary of his birth, with a silver vase, by the botanists of America. It is described by *Science* as being about eleven inches high, and is appropriately decorated with those plants which are distinctively American, and which are most closely associated with Dr. Gray. The place of honour on one side is held by *Grayia polygaloides*, and on the other by *Shortia galacifolia.* Among others, *Aster Bigelovii, Solidago serotina, Lilium Grayi, Centaurea americana, Notholæna Grayi*, and *Rudbeckia speciosa*, are prominent. The workmanship is described as highly artistic, as well as remarkably accurate. The vase stands on a low ebony pedestal, which is surrounded by a silver hoop, bearing the inscription:—

1810—November Eighteenth—1885
ASA GRAY
In token of the universal esteem
of American botanists.

The greetings by card and letter of the one hundred and eighty contributors were presented on a plain but elegant silver tray. They contained the warmest expressions of esteem and gratitude.

As we intimated last week, the death took place in Paris, on the 30th ult., of M. Bouley, President of the Academy of Sciences, after a long and painful illness. Although, says the *Revue Scientifique*, he did little original work in science, he exercised a wide influence on its general progress as well as on scientific education. He did much to raise in public consideration the art and science of veterinary surgery and medicine. Latterly, he became the ardent apostle of the teachings and discoveries of M. Pasteur, and to this work he devoted his lucid and vigorous eloquence. His books on experimental disease and on contagion are models of scientific style, as his lectures at the Museum were models of instruction.

The death is announced, at the age of eighty years, of Prof. Giuseppe Ponzi, the Italian geologist.

The fifth edition of the "Admiralty Manual of Scientific Inquiry" is now being prepared for press, under the editorship of Prof. Robert S. Ball, F.R.S., Royal Astronomer of Ireland The following is a list of the articles, with the names of the authors or revisers:—Astronomy, by Sir G. B. Airy, K.C.B., F.R.S.; Hydrography, by Capt. W. J. L. Wharton, R.N., Hydrographer of the Admiralty; Tides, by Prof. G. H. Darwin, F.R.S.,; Terrestrial Magnetism, by Prof. G. F. Fitzgerald, F.R.S.; Meteorology, by Robert H. Scott, F.R.S.; Geography, by Sir J. H. Lefroy, F.R.S.; Statistics, by Prof. C. F. Bastable, M.A.; Medical Statistics, by W. Aitken, M.D.; Ethnology, by E. B. Tylor, F.R.S.; Geology, by Prof. Archibald Geikie, F.R.S.; Mineralogy, by Prof. W. J. Sollas, D.Sc.; Earthquakes, by Thomas Gray; Zoology, by Prof. H. N. Moseley, F.R.S.; Botany, by Sir J. D. Hooker, K.C.S.I., F.R.S.

Now that M. de Lacase-Duthiers has completed his arrangements for the marine laboratories at Banyuls and Roscoff, his friends and admirers have deemed the moment a suitable one for manifesting their sense of the value of his services to the study of zoology in France, and to zoologists all over the world, and it is hoped that all those who are connected, either by their studies or their sympathies, with the zoological school founded and directed by him, will join in the work. The proposal is to have his portrait etched by one of the best French artists, and to give a copy to each subscriber of ten francs or more. The number of copies will be strictly limited to the number of subscribers. The Universities or schools of Athens, Paris, Caen, Geneva, Liége, Cairo, Edinburgh, Clermont, Besançon, Lyons,