THE MAGIC BOTTLE.

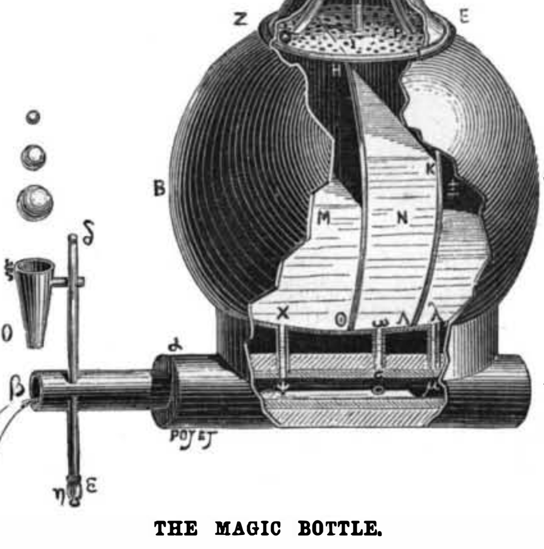
The apparatus represented in the accompanying figure presents an arrangement similar to that of the inexhaustible bottle of Robert Houdin, but it is more ingenious. The problem proposed, as enunciated by Heron, the Greek engineer, who describes the apparatus, is as follows: Being given a vessel, to pour into it, through the orifice, wines of several kinds, and to cause any kind that may be designated to flow out through the same orifice, so that, if different persons have poured in different wines, each person may take out in his turn all the wine that belongs to him.

Let $A B$ be a hermetically closed vessel whose neck is provided with a diaphragm, $E Z$, and which is divided into as many compartments as the kinds of wine that it is proposed to pour into it. Let us suppose, for example, $H \Theta$ and $K \Lambda$ are diaphragms forming the three compartments, M, N, and Ξ, into which wine is to be poured. In the diaphragm, $E Z$, there are formed small apertures that correspond respectively to each of the compartments. Let O, Π and P be such apertures, into which are soldered small tubes, $\Pi \Sigma$, $O T$ and $P \Upsilon$, which project into the neck of the vessel. Around each of these tubes there are formed in the diaphragm small apertures like those of a sieve, through which the liquids may flow into the different compartments. When, therefore, it is desired to introduce one of the wines into the vessel, the vents, Σ, T and Υ are stopped with the fingers, and the wine is poured into the neck, Φ, where it will remain without flowing into any of the compartments, because the air contained in the latter has no means of egress. But, if one of the said vents be opened, the air in the compartment corresponding thereto will flow out and the wine will flow into such compartment through the apertures of the sieve. Then, closing this vent in order to open another, another quantity of wine will be introduced, and so on, whatever be the number of wines and that of the corresponding compartments of the vessel, $A B$.

Let us now see how each person in turn can draw his own wine out through the same neck. At the bottom of the vessel, $A B$, there are arranged tubes, which start from each of the compartments, to wit: The tube, $\chi \psi$, from the compartment, M, the tube, $\omega \sigma$, from N, and the tube, $\lambda \mu$, from Ξ. The extremities, ψ, σ and μ, of these tubes should communicate with another tube, α, in which is accurately adjusted another, $\beta \Gamma$, closed at Γ at its lower extremity and having apertures to the right of the orifices, ψ, σ and μ, so that such apertures may, in measure as the tube revolves, receive respectively the wine contained in each of the compartments and allow it to flow to the exterior through the orifice, β, of the said tube, βT. To this tube is fixed an iron rod, $\delta \varepsilon$, whose extremity, ε, carries a lead weight, η. To the extremity, δ, is fixed an iron pin supporting a small conical cup whose concavity points upward. Let us therefore suppose this truncated cone established, its wide base at ξ, and its narrow one (through which the pin passes) at θ.* Again, one must have small leaden balls of different weights, and in number equal to that of the compartments, M, N and Ξ. If the smallest be placed in the cup, $\xi \theta$, it will descend on account of its weight until it applies itself against the internal surface of the cup, and it will be necessary to so arrange things that it may thus cause the tube, $\beta \Gamma$, to turn so as to bring beneath ψ that one of the apertures that corresponds to it and that will thus receive the wine of the compartment, M. This wine will then flow as long as the ball remains in the cup. If, now, the ball be removed, the weight, η, in returning to its first position, will close the orifice, ψ, and stop the flow. If another ball be placed in the cup, a further inclination of the rod, $\varepsilon \delta$, will be produced, and the tube, $\beta \Gamma$, will revolve further, so as to bring its corresponding aperture beneath σ. Then the wine contained in the compartment, N, will flow. If the ball be removed, the weight, η, will redescend to its primitive place, the aperture, σ, will be closed and the wine will cease to flow. Finally, upon placing the last ball (which is the heaviest), the tube, $\beta \Gamma$, will turn still more, so as to cause the flow of the wine contained in the compartment, Ξ.

It must be remarked that the smallest of the balls should be so heavy that when placed in the cup it shall outweigh the weight, η, and consequently bring about the revolution of the tube, $\beta \Gamma$. The other balls will then be sufficient to cause the revolution of the said tube.—Les Origines de la Science.

*The text does not agree with the figure given by the MSS. Moreover, there is an arrangement here that it is difficult to understand from Heron's description.



THE MAGIC BOTTLE.

BICYCLE "GEAR"—WHAT IT MEANS.

In a discussion of the relative merits of their machines by two riders of the wheel, it is safe to say that after the invariable question, "What make do you ride?," the next will be, "What is the gear?" There is probably no feature of the wheel which is more discussed than this, or in which a wider difference of dimensions exists; yet, strange to say, there is no feature which is less understood.

There are thousands of riders who have no clear perception of the change of mechanical conditions which takes place when, by substitution of a smaller sprocket on the rear wheel, he "raises the gear" of his machine.

True, when he mounts and begins to apply pressure to the pedals, he is sensible of a change which in its effects is truly remarkable. If his first ride with the high gear be taken on a smooth and level road, for the first few revolutions of the cranks he will be disappointed, if not disgusted, at the sluggishness of the machine, and he will have to apply a much greater pressure to the pedals than was necessary on the old gear. When the bicycle is fully in motion, however, he will be agreeably surprised to find that, with the same speed of rotation of his pedals as with the low gear, and apparently with the same pressure, he covers what to his pleased and excited imagination appears to be fifty per cent more distance. His satisfaction will last until the first hill or a head wind is encountered, when all the life and mettle will suddenly die out of his "high gear" wheel, and to the redoubled pressure on the pedals there will be apparently but little response.

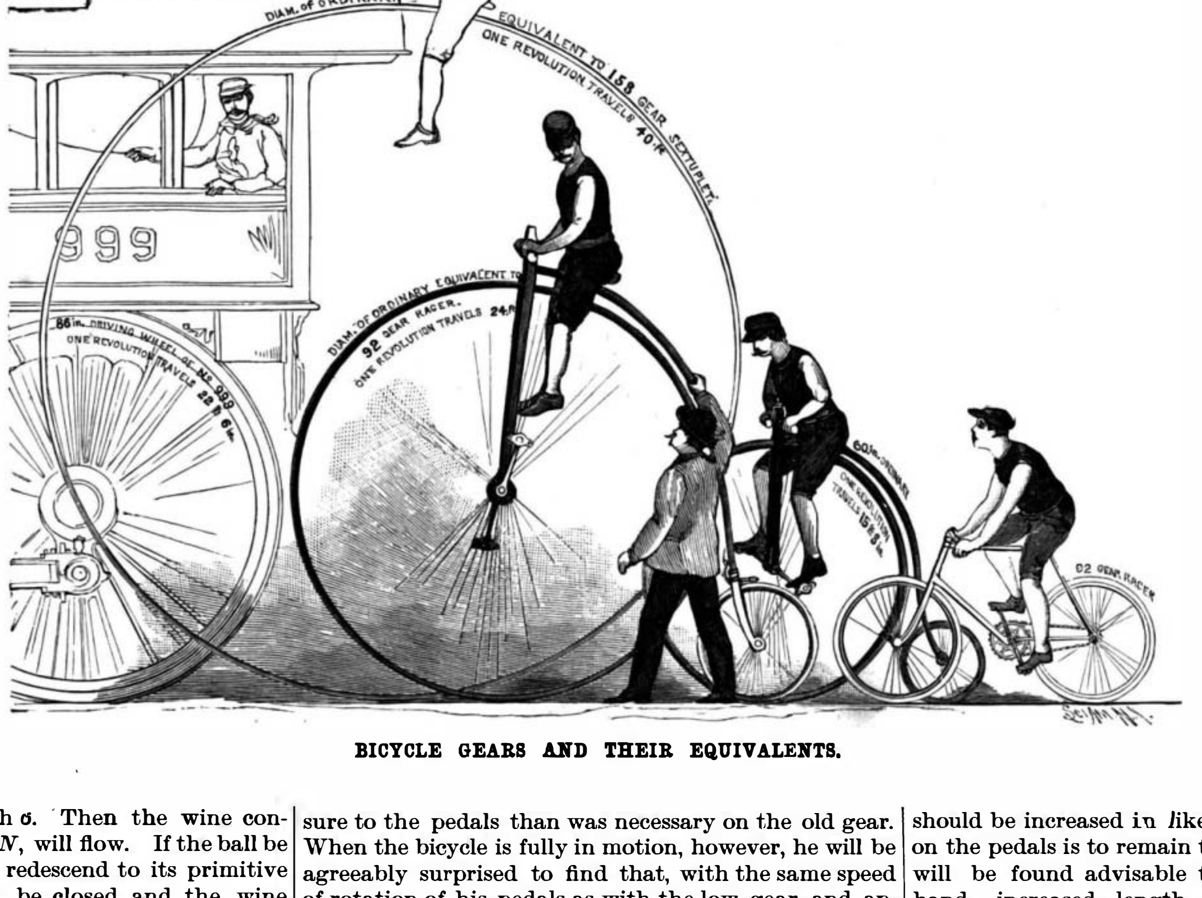
For the benefit of those of our readers who may not have a clear conception of the part played by "gear" in the mechanics of the bicycle we have prepared the accompanying diagram. The comparison is based upon the proportions of the now extinct "ordinary," or high wheel, bicycle; and it shows how the introduction of the rear-driven "safety," with its multiplying gear, has increased the capacity of the bicycle in respect of the amount of ground which can be covered by one revolution of the pedals. In the old "ordinary" bicycle, in which the cranks were attached directly to the driving wheel, the diameter of driving wheel which a rider could use was determined by the length of his leg. For this reason a 50 to 52 inch wheel was the common size, and a 60 inch wheel was an object of positive wonder on the road or on the track. This was the size ridden by Dr. Cortis (the Zimmerman of those days) when in 1880–81 he astonished the world by riding 20 miles in one hour on the track. In those days it was largely the high velocity of the pedals that limited the speed, and every rider chose the largest wheel that he could comfortably bestride, without impairing his effective work on the cranks.

The introduction of the rear-driven safety bicycle, with its multiplying gear, has changed all that, and, as our illustration shows, the short rider can now bestride a bicycle the effective diameter of whose driving wheel may be greater than that of our swiftest express locomotives. In passing it may be mentioned that if the rider of a 72 gear safety were seated upon an ordinary of equivalent diameter his eyes would look out upon the world from a point some 9 feet above the ground, and the riders of the 153 gear sextuplet would look down upon the earth from an elevation of fully 16 feet.

The distance traveled for one revolution of the cranks of the largest ordinary bicycle is 15 feet 8 inches; for the 92 gear racer it is 24 feet; and for the 153 gear sextuplet it is 40 feet; and such has been the improvement effected by the rigidity of the safety frame, the better position of the rider for his work, the excellence of the bearings, and, above all, by the recuperative action of the pneumatic tire, that the cranks of the 92 gear, modern, racing bicycle can be propelled with greater ease than those of the old 60 inch ordinary machine; as the respective speeds attained by two types would seem to prove. But while this is true on the race track, where the riders are men of muscle and endurance, on the country road the advantages of excessively high gear are not so manifest. For although the rider of an 80 gear machine covers about a yard more ground than the rider of a 70 gear machine, at each revolution of his cranks, he has to exert theoretically one-seventh more pressure upon the pedals, provided the other conditions, such as length of cranks and weight of rider and machine, be equal. Upon the level and on good roads this extra pressure is not discernible, when once the machine is fairly under way; but upon a rough road, or in climbing a hill, or against the wind, the extra effort is very evident, and in the case of weak or tired riders, painfully so.

Broadly speaking, the question of "gear" is one of the lever, in which the radius of the driving wheel is the long arm, the crank the short arm, the resistance being applied at the long arm and the power at the short arm. When the machine is running at any given speed, the pressure on the pedal multiplied by the crank length will just equal the total resistance of the machine (due to internal friction, wind, the irregularity of the ground, and the inclination of the grade, if climbing a hill), multiplied by the theoretical radius of the driving wheel. Evidently, if the driving wheel, or gear, be increased, the length of the crank should be increased in like proportion if the pressure on the pedals is to remain the same; and in general it will be found advisable to do this. On the other hand, increased length of cranks means greater travel of the rider's leg, or increased "knee action," and an increased fatigue on this account alone.

As a rule, it may be said that the question of gear must be determined by the general make-up of the rider himself. The man of quick, nervous action will



BICYCLE GEARS AND THEIR EQUIVALENTS.