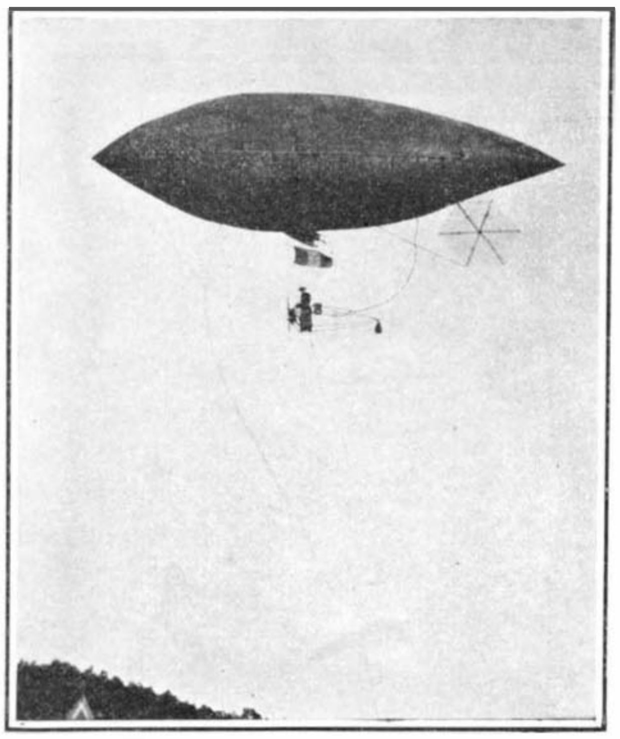
THE SANTOS-DUMONT "NO. 14."

BY THE PARIS CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

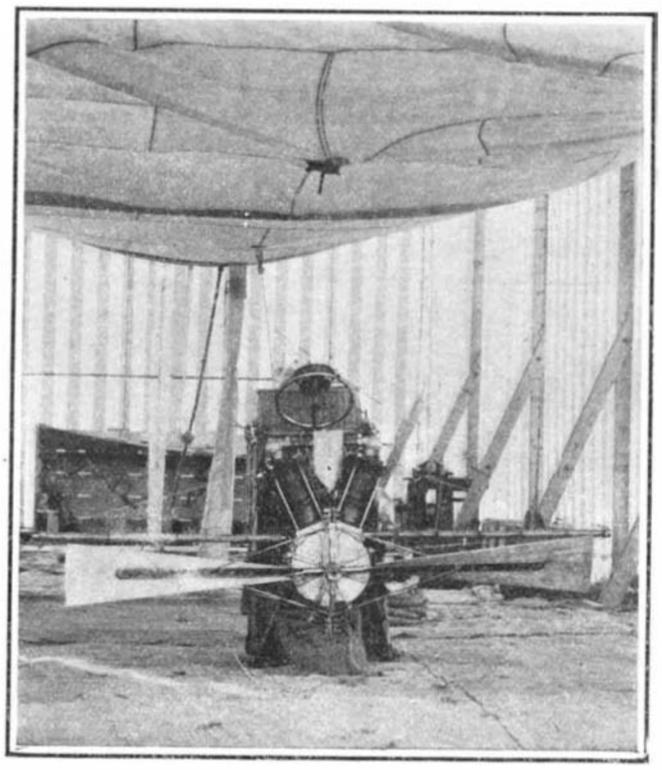
Santos-Dumont has been making the first trials of his new airship, the "No. 14," on the beach at Trouville. The balloon is housed in a shed which he had built here, and he intends to carry out a number of experiments. Starting in the latter part of August, he made a series of flights over the beach and advanced above the sea. The experiments were watched with interest by large crowds of people who are spending the season at this well-known resort. During the maneuvers, Santos-Dumont was very successful in piloting the new airship and in steering it about as he wished. He expresses himself as very well satisfied with its performance. When all is in good shape he expects to make a long flight, probably above the sea, continuing the experiments he began some time ago at Monaco.

The body of the balloon is of a rather long cigar-shaped form, and it will be noticed that the position of the largest diameter is placed somewhat near the front. This shape was adopted in some of the preceding types and was found very satisfactory. The front end is considerably pointed, however. Originally it was intended to use a very long balloon body for the "No. 14," but afterward the present form was adopted, as it seemed preferable. Some new points are to be noted both in the car and in the motor and screw. The car which is suspended some ten feet from the balloon body by fine steel piano wires, is made very short in the present case. It is large at the front end, which carries the basket, and then tapers to a sharp point in the rear. Bamboo poles are used in the construction of the car, and it is very much simplified in the present case, being reduced to four long bars, braced across in the middle by a light bamboo frame. The basket is very small and light, and is just sufficient to hold the aeronaut. It is somewhat widened out in the lower part. What is especially to be noticed in the present case is the new arrangement which Santos-Dumont has adopted for placing the motor and screw. Contrary to the method which he used in the other types, he places the screw in the front of the car. Thus it moves the airship by pulling and not by pushing it, as before. Aluminium vanes are adopted for the screw, instead of the usual covered bamboo frames. The vanes are held to the motor shaft by a light bar which is riveted to them. At right angles is placed a short steel bar, and from here three steel wires run to the blades of the screw on either side. The screw measures about 6 feet across, and the outer width of the blades is 8 inches. It runs at a speed of 2,000 revolutions per minute.

The second engraving shows the disposition of motor and screw at the front of the basket. A motor of considerable size and power has been placed on the "No. 14." The present motor is of an entirely new design, and is built by the Peugeot Company, the well-known Paris automobile builders. The cylinders are placed in V shape on a circular aluminium crank box. A smooth surface is given to the cylinders, except at the upper ends, which have the usual form of radiating wings. At the ends of the cylinders is a spherical inlet head to which comes the pipe from the carbureter. The gasoline tank and induction coil are placed on the top of the car behind the basket. Back of the motor is a bamboo cross-pole for attaching the front wires of the balloon. The steering apparatus has also been reduced to a very simple form. The rudder, a hexagonal frame stretched with silk, is jointed to the balloon body at the top, and at the bottom a single pole serves to hold it. Through the middle of the rudder runs a cross-pole whose ends are connected by wires to the steering wheel in front of the aeronaut.



The Latest Creation of the Brazilian Aeronaut, in Flight.



The Airship in the Shed, Showing the Arrangement of the Motor and Propeller.

THE SANTOS-DUMONT "NO. 14."

To copper the surface of brass articles, all that is required is to wind a piece of wire round them, and dip them in dilute sulphuric acid. The zinc is dissolved from the surface of the brass, but the copper remains undissolved, and the article will appear as if coated on the surface with a layer of pure copper.

Obtaining Thin Metal Wires by Electrolytic Means.

In a recent paper before the French Academy of Sciences, Mr. Henri Abraham suggests a method for obtaining very thin metal wires which is somewhat similar to the well-known Wollaston process of making platinum wires. The wire which is to be reduced in cross-section is taken as positive electrode in an electrolytic bath; its electrical resistance is measured from time to time, the current being stopped as soon as the cross-section of the wire has attained the figure required. The electrolytic bath should be rather dilute so as to have a very great resistance, when the current will be uniformly distributed throughout the length of the wire without its being necessary to give the two electrodes a strictly determined relative position. In fact, nearly the whole of the resistance of the liquid will be in the immediate neighborhood of the thin wire.

Distilled water containing some thousandths of its weight of copper sulphate can be used as a bath when dealing with copper wire, or else a similar amount of silver nitrate if silver wires are to be treated.

The operation should be controlled so as to be rather slow in order to allow the metallic salt forming around the wire to diffuse into the bath. Unless this precaution be taken, electrolysis will show a rather unstable behavior. Wherever the current happens to be too strong, an excess of salt will be formed, when the bath becoming too conductive, the current will augment and burn the wire. If on the other hand such salt as has been found be allowed to diffuse into the bath, the behavior of the electrolysis will prove quite stable, as the thickest parts of the wire are preferably attacked, owing to the resistance of the neighboring liquids being smallest in the neighborhood of these points.

Currents of about 0.01 ampere per square centimeter wire surface are especially convenient for the operation. The current intensity should be reduced as the wire becomes thinner, the preparation of a satisfactory wire lasting about half an hour.

The author states that wires treated with necessary caution show sufficient homogeneity to allow their new disruptive load to be calculated approximately by dividing their former disruptive load through the ratio of their present and their initial electrical resistances.

Official Meteorological Summary, New York, N. Y., September, 1905.

Atmospheric pressure: Highest, 30.36; lowest, 29.85; mean, 30.06. Temperature: Highest, 84; date, 30th; lowest, 46; date, 26th; mean of warmest day, 74; date, 30th; coldest day, 54; date, 26th; mean of maximum for the month, 72.9; mean of minimum, 60.7; absolute mean, 66.8; normal, 66.3; average daily excess compared with mean of 35 years, + 0.5. Warmest mean temperature for September, 72, in 1881. Coldest mean, 61, in 1871. Absolute maximum and minimum for this month for 35 years, 100, and 40. Average daily deficiency since January 1, — 0.3. Precipitation: 7.11; greatest in 24 hours, 3.58; date, 2d and 3d; average of this month for 35 years, 3.60; excess, + 3.51; excess since January 1, + 2.42. Greatest precipitation, 14.51, in 1882; least, 0.15, in 1884. Wind: Prevailing direction, northwest; total movement, 7,561 miles; average hourly velocity, 10.5; maximum velocity, 38 miles per hour. Thunderstorms, 3d, 20th. Clear days, 12; partly cloudy, 7; cloudy, 11.

A HUNDRED WAYS OF BREAKING YOUR NECK.

When we witness the sensational performances of acrobats, are we attracted solely by the skill exhibited in accomplishing difficult feats? There is still another element of interest, which inspires a feeling curiously compounded of admiration and a painful presentiment of danger. The guiding principle of the inventors of these acts is to give our nerves a shock more intense than any hitherto experienced, and so we are encouraging a competition in rashness in which the contestants sometimes attempt the impossible. The familiar trapeze performances, aerial ballets in which the dancers are suspended by invisible wires, balloon ascensions, and parachute drops, even the "human cannon ball" hurled by powerful springs from the mouth of a simulated cannon, though dangerous enough and often fatal, cannot compare in hair-raising power with the astounding performances of the last few years.

"Looping the loop" and its progeny are the most effective devices yet invented for producing apparent as well as real danger. Does any one still remember the American bicyclist who used to ride at terrifying speed down a steeply-inclined sixty-foot ladder? One night an attack of vertigo caused his death, but his act was less dangerous than the performances on inverted and aerial paths to which we have since become accustomed. In "looping the loop," first performed by James Smithson, better known as "Diavolo," a bicyclist starts from a platform 60 feet high and plunges down a track which extends obliquely for 100 feet to the ground, and thence rises to form a complete spiral loop 20 or 25 feet in diameter. The speed acquired by the cyclist in descending the inclined plane carries him around the loop. When "Diavolo," preceded by a great reputation, came to Paris, he found one Noiset, known professionally as "Mephisto," preparing to loop the loop at a rival music hall. In spectators supposed to be civilized these performances and their successors produced the same savage delight that was evoked by the bloody sports of the Roman circus. While several cyclists were preparing to loop the loop honestly, one man, unwilling to risk his life for the amusement of spectators, devised a loop with a concealed groove which guided his wheel and kept it from falling. His trick was accidentally exposed by a clown, who got his foot caught in the groove, and the disgraced looper fell into obloquy and oblivion. The public soon tires of the strongest sensations. The stationary loop gave place to the rotating circle called "the devil's wheel," in which the cyclist spins like a squirrel. Taking his place inside the wheel, which is about fifteen feet in diameter, he pedals in a direction opposite to that of the wheel, and thus remains at the bottom until the wheel has acquired considerable velocity. Then he stops pedaling, applies his brake, and is carried backward and upward nearly to the top, whence he rushes down, and flies around and around the revolving wheel with startling speed.

At a performance in Vienna, a cyclist, stricken with apoplexy, fell from the wheel and soon expired. But the danger of cerebral congestion is not the only one. The critical phase of the act is the last, when both the bicycle and the large wheel are being brought to rest by brakes. The bicycle lurches, and the slightest error in steering may send it through the open side of the wheel and precipitate the rider to the stage.

In Germany a genius called "Eclair" invented an infernal wheel of another sort. It was about twenty-five feet in diameter, and a smaller wheel rolled around inside of it, obtaining its impetus from a plunge down an inclined plane, which made a descent of fifty feet. To this small wheel "Eclair" was lashed in "spread eagle" fashion. He accustomed himself to this novel mode of locomotion by having himself strapped to a similar wheel, which was turned rapidly about a fixed axis by means of a crank.

More startling and perilous than any of these devices is the "circle of death." This is a large, flat, truncated cone, like the rim of a pudding dish, supported by ropes in a position slightly inclined to the horizontal, so that only one side of the lower and smaller edge rests on the stage. Bicyclists—one or more—enter the central space, and run up and around the steep side with their machines and bodies nearly horizontal. Then, to add to the apparent and real danger, the whole apparatus is raised aloft. The effect is thrilling, for the riders appear to be in constant danger of falling. In Berlin, as three cyclists were gyrating in a single circle of death, one fell and carried a second down with him. They had scarcely reached the stage when the third performer fell also.

"The globe of death," an interesting and comparatively safe act recently exhibited in a New York theater, combines some of the features of looping the loop and the devil's wheel. Two bicyclists, a man and a woman, enter a stationary lattice-work globe some twenty feet in diameter, and course around it at great speed in both vertical and horizontal circles.

All of the acts hitherto described are performed with complete circles or loops. The next development was the removal of the topmost part of the vertical loop, leaving an air space through which the bicyclist flies head downward. This feat is called "looping the gap."

Mlle. Dutrieu, "the human arrow," produces a more graceful effect by traversing a gap in a track which would not, if complete, form a loop. The first section of the track is a plane fifty feet long, inclined 30 deg. to the horizontal and terminating in a short upward curve. The second section begins with a saddle-back curve, and ends in a plane inclined upward for the purpose of bringing the bicycle to rest. The two sections are separated by a gap of fifty feet, through which the cyclist flies like an arrow. It is worthy of note that women formed a large majority of the spectators of the human arrow's first public flight.

A feat, performed by the cyclist Marok, might be called looping without a loop. The track resembles the first section used by the human arrow, but the upward curve is longer and forms an arc of a circle. At the foot of the incline and the commencement of the curve the bicycle is caught by a wire suspended from the center of this circle. The machine, therefore, after traversing the curved path, describes the remainder of the circle in the air. Meanwhile the curved path is replaced by a level one terminating in an ascent, which receives and stops the cyclist when he returns to earth and casts off the wire.

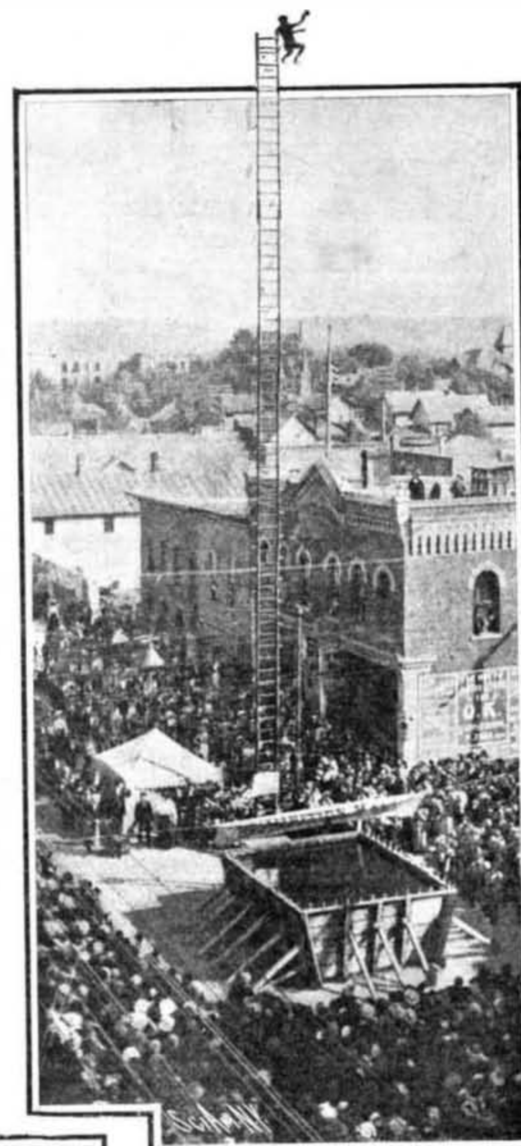
In another ingenious and terrifying variation of the human arrow, the bicycle is replaced by a four-wheeled car, which is stopped abruptly by a buffer at the end of the upward curve, while the rider is hurled through space to a trapeze some distance away and fifty feet higher. Failure to catch the trapeze means certain death.

Another startling application of the same principle is made in an open-air performance which has been given many times in America, England, and Germany. The inclined track is erected on the shore of a lake or river, and is two hundred feet long. The starting platform is a hundred feet, the top of the upward curve about forty feet above the ground. When the bicyclist rides off the end of the curve into space, he lets go his machine and dives into the water. This frightful plunge terrifies the spectators, but the real danger is that of being struck and killed by the bicycle, a fate which befell James Fleet in Chicago.

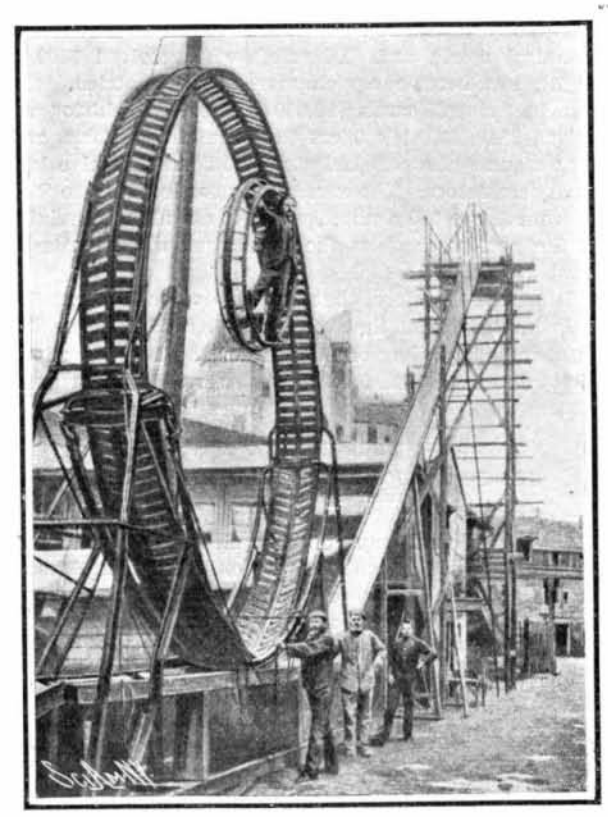
An acrobat named Thompson makes a still more perilous plunge with the aid of simpler apparatus, leaping from the top of a very long vertical ladder into a tank some distance away, which measures only forty feet in length by eight feet in width. A slight error in making the leap would bring him to the ground instead of the tank.

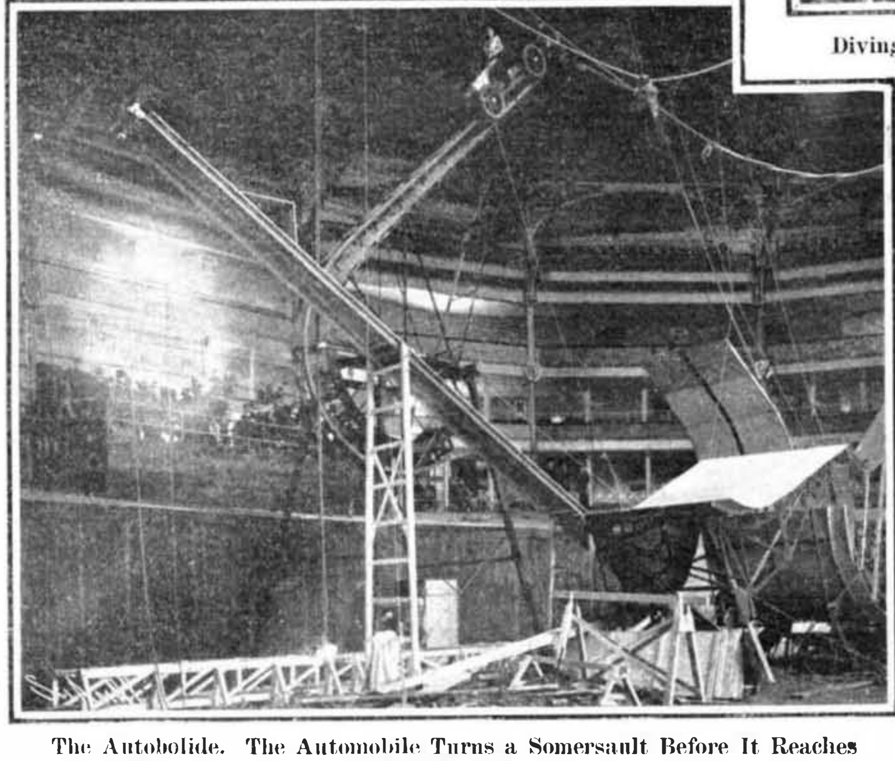
The automobile, the queen of sport, shares with the bicycle the glory of these dangerous exhibitions. One of the latest developments is the monstrosity called the autobolide, which is making fame and fortune for Mlle. de Tiers. From an elevation of forty feet the first section of the track slopes downward at an inclination of 45 deg., and at its lower end curves downward and inward to form a semicircle. Down this track and around the outside of the curve rushes an automobile weighing nine hundred pounds, which is held to the track by rollers engaging with fixed rails. Running off the end of the curved track at a speed of thirty-five miles an hour, the vehicle flies through the air, inverted, to a hollow curve which rights it and sends it spinning down a long incline with still greater velocity. The whole journey occupies just four sec-

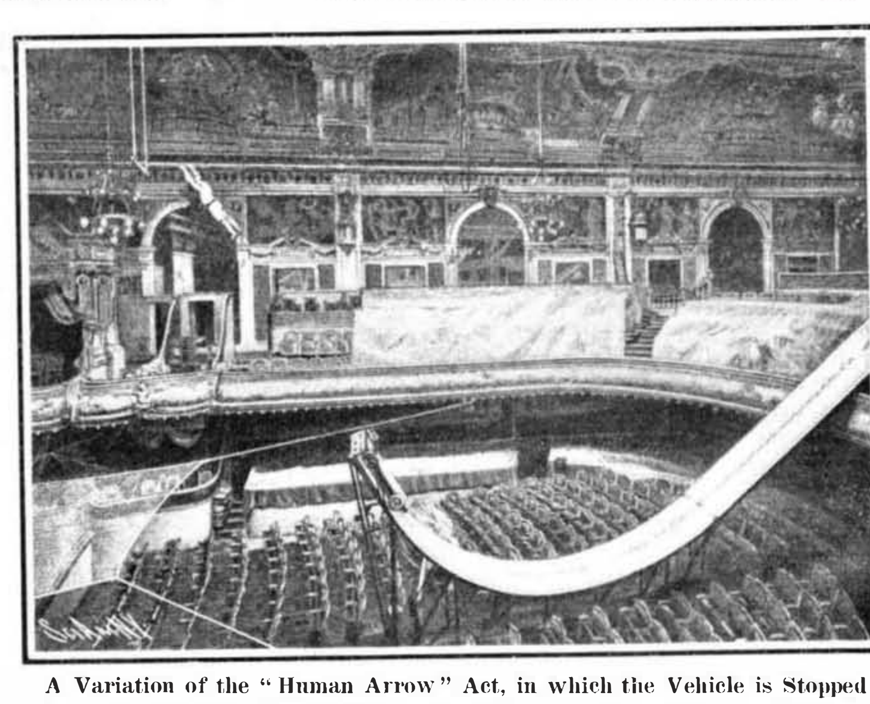

The Human Cannon Ball.


Diving into a Small Tank.


Eclair's Practice Wheel.


Eclair Lashed to a Wheel and Looping the Loop.


The Autobolide. The Automobile Turns a Somersault Before It Reaches the Ground.


A Variation of the "Human Arrow" Act, in which the Vehicle is Stopped Abruptly and the Rider is Thrown into the Air and Caught on a Trapeze.

A HUNDRED WAYS OF BREAKING YOUR NECK.

onds. As Mlle. de Tiers, inverted like her automobile, dashes around the sharp curve and is hurled into space, she experiences a painful sensation as if her head were being torn from her body, and with good reason, for the combined pull of gravity and centrifugal force exceeds two hundred pounds. The pain continues for many hours, and the danger is shown by the fact that in trials made with an empty automobile the vehicle has fallen three times. Yet this young woman has never felt the slightest fear, and she claims that at her first invitation performance she was less excited than the reporters who were present. This is the more remarkable because she is neither a seasoned acrobat nor a sportswoman, and has never even ridden a bicycle. Her act did not admit of practice. The first attempt was a sort of toss-up against fate. The woman won and has won ever since.

Another young woman has been less fortunate, for a terrible accident has abruptly terminated the exhibition of the aptly-named "whirlwind of death," in which she appeared recently at a Paris music hall. In this act the automobile, after running down an inclined plane and up a short curve, was projected into space in a nearly level position, like the bicycle of the human arrow. But when the vehicle had reached the highest point of its trajectory, it was caused, by an ingenious combination of springs and levers, to turn a complete somersault, after which it continued its flight to the receiving platform, forty feet distant from the point where it had left the first section of the course. The act was particularly thrilling because the vehicle, at the moment of the somersault, appeared to stop in its onward flight and, consequently, to be in imminent danger of falling to the floor, twenty feet below. This illusion was due to the very low position of the center of gravity, which caused the inverted body of the woman to move backward, at that instant, faster than the center was moving forward.

What is the incentive which impels these men and women to risk their lives nightly before crowds of spectators? Is it ambition, vanity, love of applause, or simply the hope of making a fortune? The American "looping the loop" was conceived in an essentially practical spirit, and "Diavolo," who received $600 a night, has become a rich man. Mlle. Dutrieu, "the human arrow," earns $80,000 a year, "Mephisto" received $140, Mlle. de Tiers $200 a night in Paris, and larger sums abroad. Imitators, of course, receive less than originators. The current pay for looping the loop is from $20 to $40 a night, which is not high, especially if the performer owns the apparatus, which costs at least $500.

It seems, therefore, that the hope of gain is not the only incentive, but that the performer, like the public, is attracted by the very danger of the act—a curious illustration of the fascination exerted by emotions which, in themselves, are disagreeable.

AIR PUMPS FOR EXPERIMENTAL PURPOSES.

BY W. P. WHITE.

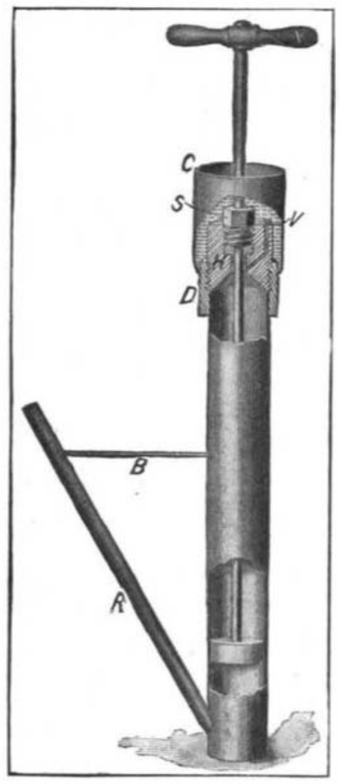
The four most important requirements for an air pump, arranged roughly in the order of their importance, are: (1) Absence of leakage; (2) absence of clearance; (3) absence of the vapor of water or other substance; (4) valves that will work with very small air pressure—so-called automatic valves. The effect of clearance or of vapor is about the same; with either we have a gas which either condenses or is compressed into the clearance space as the piston nears the end of the cylinder, to evaporate or expand again on the return stroke, thus keeping a considerable pressure always in the cylinder, and preventing the attainment of a good vacuum.

Curiously enough, the fourth of the above requirements has come to have an exaggerated importance attached to it. There have been on the market pumps which leaked badly, in which the question of clearance was neglected and that of vapor apparently never thought of, which nevertheless were the subject of great claims on account of some more or less complicated and expensive variety of automatic valve, whose advantages were usually far outweighed by the other defects of the pump. The most curious thing about the whole matter is that there has long been known a form of automatic valve (usually attributed to Prof. Tait) for many years made by one American manufacturer, which is simpler and better than most, at least, of the patented contrivances.

A really important improvement to most existing pumps would be the use of oil as a sealing material, which reduces both leakage and clearance exceedingly close to absolute zero.

Why it has not been more generally used is, to the present writer, a mystery. The idea is as old as the seventeenth century, and is familiar to-day in the mercury pump. The advantage can be seen when we reflect that the only defect of the oil pump worth mentioning, the effect of vapor from the oil, is a thing that is neglected in ordinary pumps. There is, therefore, nothing surprising in the fact that the exhaustion of the best oil pumps is measured in thousandths of a millimeter—hundreds of times as good as with ordinary mechanical pumps.

The immediate object of the present article is to point out the fact that even with the crudest construction, the oil pump is still far ahead. For instance, the pump shown in the figure was made as follows: An old bicycle pump was soldered up tight at the bottom. An inch up, a half-inch hole was drilled, and the slanting tube, *R*, soldered on, strengthened by the brace, *B*.



AN EXPERIMENTAL AIR PUMP.

This tube is to bring air from whatever is being exhausted. For the top of the cylinder a ring, *D*, cut from heavy brass tube, was soldered on, and into this screws the cylinder head, *H*, conical on the inside, so that all air bubbles may readily be swept up through the valve, *V*, which opens from the very top of the cone. The plug, *S*, makes a stuffing box for the piston rod. The piston is reversed, so as to force up instead of down. Last, but not least, a cup, *C*, to contain oil, is soldered to the ring, *D*, so that every possible opening by which air could enter is sealed by oil. Total cost, about $2. The action can be very simply described. Each up-stroke of the piston crowds out all the air above it, and when the piston returns below the side hole, air from the receiver is free to enter the empty space. In the following up-stroke the piston first, by passing the side hole, cuts off communication with the receiver, and then forces out the air above it. Tested with a McLoud gage, this pump gave an exhaustion of 0.2 millimeter. One might get more or less than this in another case, as it depends mainly on the quality of the oil. The oil in this case was commercial, heavy lubricating oil, not specially dried or treated in any way.

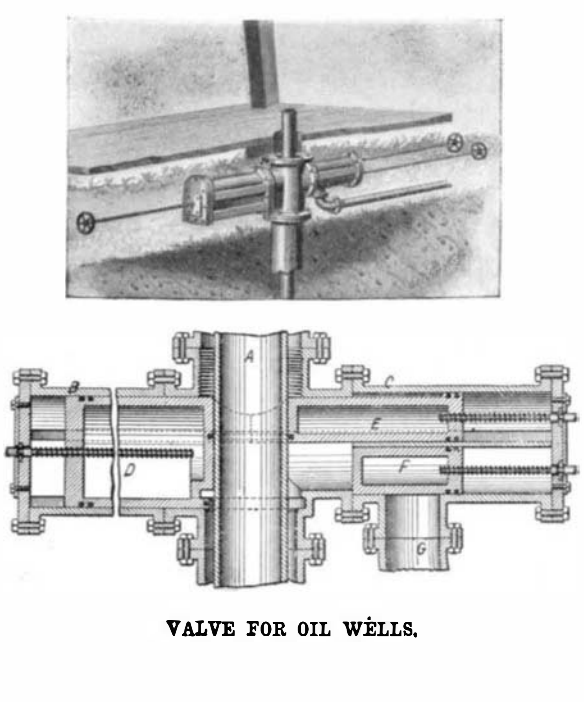
Although this pump, considering its vacuum alone, is only from five to ten times as good as the best mechanical pumps generally sold for experimental purposes, yet it really is far more useful. The excellence of these others depends upon good workmanship, and this means that they must be expensive, and that their efficiency is easily impaired by wear or by slight accidents. The oil pump is thus vastly more reliable, as well as cheaper and more durable. Moreover, the improvement in the vacuum happens to come in a way to be rather important. There are three different classes of work for an air pump: 1. X-ray work and the like, requiring a very high vacuum and all sorts of precautions outside the pump itself—of all of which there is no question here. 2. At the other extreme, the ordinary phenomena of atmospheric pressure, requiring a vacuum of several centimeters or better 3. Geissler tube and other similar electrical phenomena, ranging from 2 millimeters down, but showing special interest between 1 and 0.1 millimeter. The average pump just enters this region, but stops short of the best part of it—that is, when in fine condition; when in poor condition it is good only for the second class of phenomena, which can be shown, though not as well, by a common aspirator. Thus a moderately good oil pump opens one of the most beautiful and interesting classes of phenomena in nature.

An ordinary school pump can easily be made into an oil pump of the type here described. A hollow cone can be cast of type metal directly in the cylinder, and the rest is a matter of solder and sheet metal. Nearly every school has one or more old, worn-out pumps in its truck pile, which can easily be made better than new, since a large air leak will only leak a little oil, and a slight oil leak is a trifling inconvenience which does not affect the vacuum.

For moderate results albolene or liquid vaseline is a good oil to use, as it is not acted on by sulphuric acid, and can therefore be freed from water vapor at any time by shaking it up with the concentrated acid. For the best results no great expense is needed, but two problems are to be solved: 1. To find or make a vaporless oil. 2. To find a simple method of getting double exhaustion, so that the chamber which draws from the receiver does not come to atmospheric pressure at any time, but delivers into a good vacuum. There are at least three simple ways of doing this without using two cylinders, but this whole question is beyond the purpose of the present article.

VALVE FOR OIL WELLS.

Pictured in the accompanying engraving is an improved valve for oil wells which provides a tight joint at the stem of the drill and permits control of the oil during the drilling operation and thereafter. In the general view the drill stem may be seen passing through the floor of the derrick into the valve casing, which is bolted to the top of the oil tube. The details of the valve are clearly shown in the section view. The drill stem is indicated at *A*. Bolted to opposite sides of the main valve casing are two bonnets, *B* and *C*. The bonnet, *B*, is formed with rectangular base and sides and a dome-shaped top. Within it is the valve, *B*, which, in cross section, conforms exactly to the interior of the bonnet. The latter is provided with grooves adapted to receive tongues formed on the body of the valve. The inner extremity of the valve has a semi-cylindrical face, which fits closely around the drill stem, *A*. A perfectly tight joint is insured by the provision of hydraulic packing. The body of the valve is also made perfectly tight with packing strips set both transversely and longitudinally. The bonnet, *C*, which is of cylindrical form, is divided by a central partition into two chambers, one of which contains the valve, *E*, and the other the valve, *F*. The valve, *E*, like valve, *D*, is formed at its inner extremity with a curved face, adapted to fit snugly against the drill stem, *A*. The valves are operated by threaded valve stems, as illustrated. Under normal conditions, when the drilling operation is in progress, the stem, *A*, passes down through the body of the valve casing. The valves, *D* and *E*, are advanced so that their forward faces abut against the sides of the drilling stem, and form a tight joint thereabout, so as to prevent the upward flow of gas, oil, or sand. The overflow is controlled by means of the gate valve, *F*, which may open communication, if desired, with the overflow pipe, *G*. When the drill stem, *A*, is removed, the main valve, *D*, may be advanced so as to close the opening from the oil tube into the valve casing. The entire bonnet, *C*, may now be removed, if desired, and the pipe line connected directly in the position which the bonnet occupied. If the well is to be permanently closed both bonnets may be removed and a plug screwed down, so as to cut off communication between the oil pipe and the valve casing. The valve stems are operated by hand wheels which project beyond the end of the derrick floor, enabling them to be conveniently reached. Mr. Horace D. Bernard, 30 Chartres Street, Houston, Texas, is the inventor of this improved valve.



VALVE FOR OIL WELLS.

As the result of experiments extending over several months, it has been decided to abandon hard wood for street paving purposes in London. Hard wood not only severely damages the concrete foundation, but wears unevenly. The edges of each block wear away before the center, and the result is a corduroy-like ridge, which makes a very rough surface for driving over. Soft wood, on the other hand, wears evenly; the external pressure tends to spread the wood at the edges, thereby filling up the interstices between the blocks, and giving a perfectly even, homogeneous surface. The life of a soft-wood pavement is about ten years, and it has the additional advantage of wearing right down.

SCIENTIFIC AMERICAN

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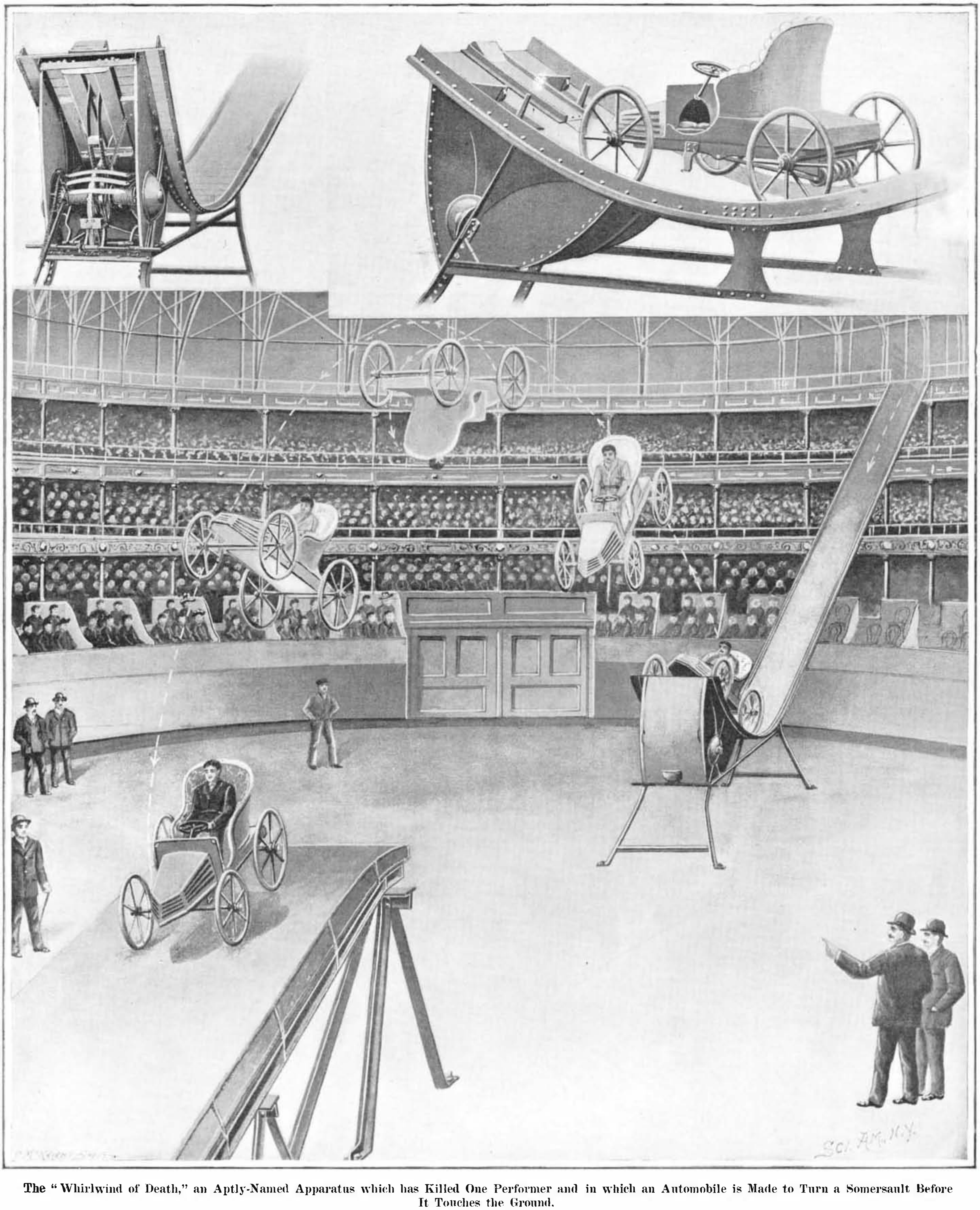

The "Whirlwind of Death," an Aptly-Named Apparatus which has Killed One Performer and in which an Automobile is Made to Turn a Somersault Before It Touches the Ground.

A HUNDRED WAYS OF BREAKING YOUR NECK.—[See page 302.]