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.

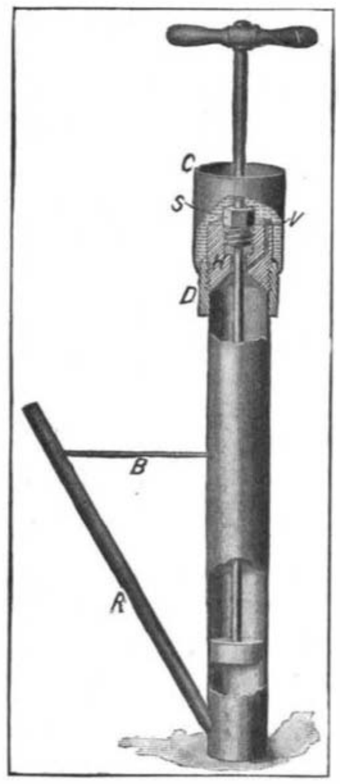
The four most important requirements for an air pump, arranged roughly in the order of their importance, are: (1) Absence of leakage; (2) absence of clearance; (3) absence of the vapor of water or other substance; (4) valves that will work with very small air pressure—so-called automatic valves. The 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.

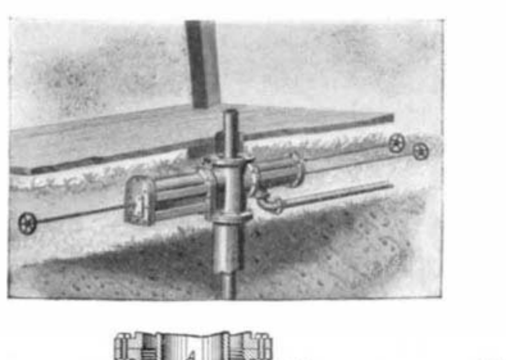
Although this pump, considering its vacuum alone, is only from five to ten times as good as the best mechanical pumps generally sold for experimental purposes, yet it really is far more useful. The excellence of these others depends upon good workmanship, and this means that they must be expensive, and 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.

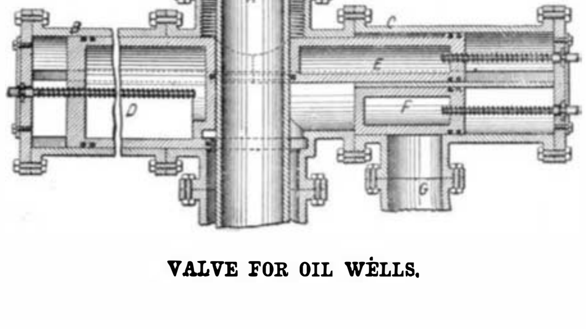
An ordinary school pump can easily be made into an oil pump of the type here described. A hollow cone can be cast of type metal directly in the cylinder, and the rest is a matter of solder and sheet metal. Nearly every school has one or more old, worn-out pumps in its truck pile, which can easily be 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.