work advances, branches will be taken through the transverse galleries. The water from this main will be used for clearing away the broken rock, as well as for cooling. But it will only be applied to this purpose for a minute or two after each attack, and at the most once in two hours, so that its temporary stoppage in the upper headings will not be of any consequence.

(12) Transport.—Lines 2 ft. 7½ in. gauge, and with 40 lb. rails, will be put down in each heading. There will be branches at each cross gallery, and it is for this reason that they are oblique, instead of being made at right angles to the main tunnels. Special steam locomotives will be built for service inside the tunnel. They will weigh sixteen tons when in working order, and will be constructed with extra large boilers, so that there may be no need for stoking while inside the tunnels. They are to be capable of going round a curve of 50 ft. radius. The trucks are to be on metal frames, and are to have springs, buffers and elastic draw bars. They must have a capacity of 70 cubic feet, and seats for three men are to be provided back and front. As a general rule, the trains will enter by heading II, and leave by heading I, so as to travel in the same direction as the ventilation. The trucks will be backed into the transverse galleries, and the fans will be run more slowly while a train is going up.

(13) Hygienic Arrangements.—Dressing rooms, baths, etc., are to be provided as near as possible to the entrances of the tunnels, to which they are to be connected with covered ways. Each workman will be provided with working clothes, which will be dried and cleaned after each shift. The report also describes the sanitary arrangements inside the tunnel.

(14) Outside Erections. North Side.—These buildings are on the left bank of the Rhone, and are so arranged that they can be used while tunnel II is being finished without interfering with the work of tunnel I. The work at the north end may be divided into three periods. The first of these is the first twelve months of construction, before the water conduits from the Rhone, and the turbines, etc., have been finished. During this time 170 horse power will be required; of this 140 horse power will be for six rock drills and 30 horse power for working small hydraulic ventilators, and also for a small workshop. This power will be provided by three 60 horse power semi-portable engines, of which one will be started about two months after the commencement of the works, and the others within the two subsequent months. These engines will be kept as a reserve till the termination of the work.

The second period will last a year and a half, or two years, until the first three miles have been completed. During the first and second periods an 8 in. bore hole is to be put down near Berisal, which is to penetrate the tunnel three miles from the mouth. The depth of this hole will be about 2,300 ft. From the Steinenbach, at an altitude of 5,900 ft., a quantity of water equal to twenty-two gallons per second will be taken and conveyed in pipes, carefully protected from the frost, to this bore hole, and down it to the tunnel, where it can be utilized for drilling or for cooling. It will give a pressure at the drilling machines of about 1,500 lb. to the square inch. If, contrary to all expectation, the bore hole should not be made successfully, this water will be conducted by a special conduit to the head of the tunnel, where it will enter the main.

During this second period, 750 horse power will be required; 200 horse power for eight rock drills, 250 horse power for the ventilating fan, 200 horse power for internal and external electric lighting, and 100 horse power for workshops, saw mill, mortar mill, etc. It is not expected that cooling water will be required before the end of the third mile, as it is only then that the distance from tunnel to surface commences to become considerable.

The duration of the third period, from the third to the sixth mile, will be from two to two and a half years. In this, it is estimated that 500 horse power will be required for ventilation, 200 horse power for electric lighting, and 100 horse power for workshops; this power will be taken from the Rhone. The supply of five gallons of water per second for the rock drills and of thirteen gallons per second for cooling, or for clearing away the broken rock, will be furnished by the Steinenbach, which will come into the tunnel, as described above, at a pressure of 1,500 lb. per square inch.

South Side.—It was not easy to find a suitable site for the necessary buildings on this side, as the valley is narrow and descends rapidly. The baths, laundry and dressing rooms are on the right bank of the Diveria, and are connected by a covered gallery with the heading. Two bridges will be made over the Diveria; trains entering or leaving the tunnel will cross the upper bridge, while the lower one communicates with the dressing rooms, etc.

The power house, workshops, stores and offices are to be on the left bank of the Diveria, but at two different levels, one 17 ft. above the other. The machinery will be on the upper level, while wood, stone, sand, lime, etc., will be stowed on the lower; the offices and stores will be placed between them. In deciding the position of these buildings there were two considerations—first, that it should be possible to finish tunnel II without interfering with the traffic of tunnel I; and secondly, to impede the circulation on the road as little as possible during construction.

At the southern end, the work is divided into two periods. The first period is, as at the northern end, the first year of construction, until the turbines are in working order. The power needed will be 180 horse power for six rock drills working at 1,500 lb. pressure, and 30 horse power for the small ventilators and small workshops. Three portable engines, each of 75 horse power, will supply this. As on the north side, one of these will be in use two months after the works are commenced, and they will be retained as reserve force till the completion of the works. The second period will last for four or four and a half years, till the six miles from the southern end are finished. The motive power needed will be 1,700 horse power, divided as follows: For ten drilling machines, 350 horse power; for cooling and hydraulic clearing, thirteen gallons per second at a pressure of about 750 lb. per square inch, 550 horse power; ventilation, 500 horse power; electric lighting, 200 horse

power; and workshops with saw mill, mortar mill, concrete mixer, etc., 100 horse power.

Besides hotel, canteen and dwellings for workmen and overseers at Iselle a hospital is to be erected at Rosso, near Varzo; and houses for the engineers will be constructed as they may be required. The large ventilating fans will be placed close to the entrance of the tunnel as at the north end.

AN IMPROVED BICYCLE SADDLE.

THE saddle, of all the parts of the bicycle, is the one that is still in its infancy. In the mechanics in general of the bicycle, at present so well elaborated, the saddle has remained rudimentary. It is a piece of leather stretched over springs, almost at hazard. To write it is to express the opinion of the generality of wheelmen, all of whom, more or less, have had to suffer from its bad construction. In the rare indispositions that the bicycle is capable of occasioning, the saddle is to blame three times out of four, and accidents to the perineal

THE SAR BICYCLE SADDLE.

1. Diagram showing the position of the bones of the pelvis upon an ordinary saddle (M, iliac bone; 1, ischion; F, femur). 2. Diagram showing the position upon a Sar saddle. 3. The Sar saddle (M, the front plate; B, the cantle; C, re-entrant part for the free passage of the thigh; m and n, cavities for the ischions).

organs, in male as well as in female cyclists, have become almost the only mishaps that are still to be dreaded. There is nothing here that prejudices the high hygienic character of cycling recognized and installed by medical authorities, but simply an indication of the extreme importance that a study and a common-sense construction of the saddle has in this sport.

Appropos of this, it may be asserted that the worst saddles are those that are most suspended and the softest. The rider sits as if fitted into them, and rests almost exclusively upon the perineal organs. We shall speak here only from a hygienic standpoint, for from a mechanical one it will be understood that such a seat is the cause of a great waste of strength at the expense of the propulsion of the machine. As the springs are compressed under the weight of the rider, the first work that the leg produces in bearing upon the pedal consists in easing these springs by elevating the body, and not in actuating the machine. Upon the track, where it is indispensable that the racer shall not waste his strength, the saddles have no spring. But it is evident that the form of the saddle is much more important than is its suspension.

A cyclist of long experience, Mr. Pansard, aided by the judicious advice of Dr. Hammon, has just got up a saddle, the trade mark of which is a pea fowl and the name "Sar" saddle, and which offers better than a play on words the indisputable advantage of at length forming a common sense bicycle seat.

Every cyclist rests upon the saddle (Fig. 1) through

the two lower parts of the iliac bones, M, called the ischions, 1. While his femur, F, works in actuating the machine, his body takes the inclined position, r s. In the construction of the ordinary saddle that this figure represents, the front plate, a, and the cantle, b, are in the same horizontal plane. The result is that the ischions are displaced upon the even surface of the leather, that r s forms an acute angle, r s t, with t v, and that the rider insensibly approaches the front plate of the saddle, upon which he comes to be no longer seated, but literally astride of. Hence he no longer bears upon his natural sitting points, but upon the base of the abdomen. He endeavors indeed to push himself backward by bearing upon the handle bar, but he tires his wrists and falls back upon the front at the least jolt. Moreover, the part, c, is but slightly curved within, and every backward movement made by the thigh has the effect of aiding this incorrigible sliding of the body upon the front plate.

The Sar saddle (Figs. 2 and 3) happily remedies all such inconveniences. Its cantle, B, has an inclination such that the line of the body, r s, forms a right angle with t v. The ischions therefore take a fixed bearing point upon it that the special shaping of the leather to conform to the gluteal muscles and the two depressions, m and n, for the ischions much facilitate. The rider's seat is, so to speak, fitted into this saddle, and deviates neither to the front nor the rear at the most violent jolt. Moreover, the front plate, A, is hollowed out for its entire length, so that the perineal organs can bear upon a hard part at no moment, while the cheeks of the saddle are curved almost at right angles at C in order to permit of a free play to the thigh.

The result of these happy modifications is undoubtedly an increase of speed for the cyclist.

A large number of experiments made at different times have shown that the force that the rider lost upon an ordinary saddle in slidings and reinstatements, of which he was often even unconscious, are employed by him upon the Sar saddle in work upon the pedal crank.—La Nature.

A SCHICHAU TORPEDO BOAT.

MOST war vessels are now provided with torpedoes, but on account of their size they cannot approach the enemy near enough to use their weapons effectively, and therefore the use of special torpedo boats has become necessary. These are small, gray in color and have few noticeable objects on deck, so that they can steal upon the other vessels almost unobserved at night. They can send the torpedoes a distance of 1,000 feet to 1,300 feet, carrying destruction to any vessel that fails to light up the surface of the water about it by means of search lights.

Our illustration (for which we are indebted to the *Illustrirte Zeitung*) shows a torpedo boat that was constructed at the Schichau works in Elbing, and was sold, with four similar boats, to the Brazilian government. This boat is 151 feet long and has a displacement of 120 tons. The two engines, which together indicate 1,500 horse power, operate two screws, giving the boat a speed of 26 knots per hour. Like most of these boats, it is provided at the bow with the so-called whaleback deck, under which are the quarters of the crew. The devices for controlling the vessel are arranged in two little towers, one forward and one aft, on the top of each of which a revolver is pivoted. Our engraving shows the crew busy amidships and aft with the torpedo projectors, which are arranged to turn on rails. Besides these, there are on the deck only the smokestack, the ventilator, the lights for the engine room and a small mast used for signaling purposes. One small boat is the only means of communication with the shore or other vessels, or of escape in case of accident. Although these boats are built of light steel, and are not high above the water line, they are quite seaworthy, as has been proved by their voyage to Brazil.

COLD STORAGE AND COLD ROOMS FROM COMPRESSED AIR.

By G. D. HISCOX, M.E.

IN view of the largely increasing demand for the means of preserving food in the warmer sections of the United States, and in tropical climates, where ice cannot be obtained, or the cost is so great as to preclude its use, the use of compressed air as a constant cooling medium is one of the means at the command and control of every one who is able to place a small outlay

TORPEDO BOAT.—DRAWING BY H. PENNER.

for a valuable boon to household comfort; and for the profit that may be realized from the power to preserve fruit, vegetables and meat for sale, or for the time and opportunity for shipment to a market.

There are large tracts of country in the southern section of the United States in which are situated plantations and farms, the owners and managers of which, having the financial means to supply comforts to life by the use of cold preserved food, who are entirely beyond the reach of ice, either natural or artificial, and to whom such wants may be supplied by the means of any small power such as a windmill, a waterfall or a gasoline engine, operating a pump for the compression of air. In Mexico, the Central American and South American states, the field for useful work by wind and water power alone for contributing to domestic comfort by the preservation of food is immense; where power from nature as through a windmill or waterwheel can be utilized. The distance need not be considered beyond the cost of a small pipe for conveying the compressed air, as a considerable length is needed to cool the air to its normal temperature which has been heated by the operation of compression; when by expansion to atmospheric pressure the

column of heat developed by compression on the left, while the upper or adiabatic curve shows the condition of temperature, pressure and volume at the moment of compression. The lower or isothermal line shows the shrinkage of the volume due to the cooling of air to its normal temperature.

The vertical dotted lines from the intersection of the isothermal line with the horizontal lines of pressure, meeting the atmospheric line, form the starting points for the curves of expansion extended on the same scale of temperature corresponding with the scale of compression.

The intersection of the dotted lines extended through the curved lines of expansion show also in a graphic way the fractional expansions from one stage of compression to another lower one as measured by the expansion scale at the left hand side. Thus a volume of air at 60 lb. pressure and 60° temperature, when expanded to 30 lb. pressure, its temperature will fall to the intersection of the extended dotted line of 30° with the 60 lb. curve, which measured on the expansion scale is -57°, and so on for any other pressures.

In applying the conditions of air expansion to the practical effects of refrigeration or the cooling of rooms

part to the required temperature in the shortest possible time.

As to the work that compressed air will do in cooling rooms, there is a large marginal range in the quantity of free air required for a specific temperature, due to the conditions of temperature of the material to be cooled and the amount of compression in the air to be expanded for this duty.

Assuming, for example, a cold room for a farm or plantation of 1,000 cubic feet capacity, or say 12 feet square by 7 feet high, thoroughly insulated, with a double door at side for storing; a single or trap door with a small ventilator at top, with steps from the trap door for every-day use, and also lighted from the top. By this means a loss of cold air is prevented by its greater specific gravity holding it at the bottom. The room may be kept uniformly at 34 degrees Fah. in an outside temperature averaging 80 degrees. To cool such a room from 80 degrees to 34 degrees requires a loss of 46 degrees in a volume of 1,000 cubic feet of air, say 77 pounds, the specific heat of which is 0.2377 water = 1. Then $77 \times 0.2377 = 18.3$ heat units must be absorbed for every degree of change in temperature. Then $18.3 \times 46 \text{ degrees} = 841$ heat units must be abstracted to bring it to 34 degrees Fah., leaving out the cooling of the walls, which will be only a matter of time in the initial operation.

Assuming to use an air pressure of only 30 lb. per square inch, then in the graphic diagram, tracing the dotted line from the isothermal curve junction of 30 lb. and following its curve of expansion, we have -188 + 60 degrees to the atmospheric line = 198 degrees difference in temperature by expansion from 30 lb. pressure, or 198 heat units per lb. of air. Then $\frac{841}{198} = 4.24$ lb.

or 55½ cubic feet of free air at 30 lb. pressure will be required to cool the room to 34 degrees.

A compressor of 5 cubic feet per minute capacity, using less than one horse power will furnish enough air to reduce the temperature of the room from 80 degrees to 34 degrees in about fifteen minutes, and should then easily furnish cold air for absorption of heat from the material of storage and to supply the waste made necessary by ventilation and radiation with a constant work of less than a half horse power. This power comes within the scope of a cheap class of water wheels, water motors, and the smaller sizes of gasoline engines and windmills.

Where intermittent power must be used, as with windmills and power engines, a system of storage of compressed air may be used with perfect satisfaction as affording a constant flow of air into the cold room and also into a small refrigerator, which will be found a most useful adjunct for kitchen use and the cooling of drinking water.

The amount of pipe surface required for cooling compressed air to the normal temperature is a matter of much importance, as its delivery at the point of expansion, to be effective, must be at, or very near, the temperature of the outside atmosphere.

The method of keeping the air cooling pipe at the proper temperature fixes the amount of pipe surface to be provided.

For 30 lb. pressure, 15 square feet of cooling surface per cubic foot of free air used per minute is a fair proportion for an air-cooling coil exposed to a free circulation of the atmosphere and shaded from the sun's heat.

This would indicate a coil of 150 feet of 1½ inch pipe for the requirement of a cold room as above stated, which may also include the leading pipe from compressor to cold room, if favorably situated for cooling. Where it is convenient to use water for cooling, either by a sprinkler or by submerging the coil in a tank of water fed from a stream or by pumping, the size of the coil may be greatly reduced, according to the temperature of the water.

For an intermittent power as a windmill, or a gasoline engine that would not be convenient to run at night, a storage of air will be necessary by the use of a proportionally increased power during the day for accumulating compressed air in tanks.

The storage of sufficient air for a 10 hours run of the above plant will require tanks to hold about 1,200 cubic feet, or say 3 tanks of cylindrical form 5 feet diameter, 21 feet long. As the atmospheric temperature always falls at night in tropical and semi-tropical regions, the conditions of compressed air supply may be much modified in the storage quantity above outlined, and where constant power can be obtained, the whole question of cold storage for private use becomes a cheap and simple one.

The arrangement of the nozzle or orifice for delivering the compressed air, and at which point the expansion takes place, is important and requires its area to be exactly gauged to the proper size for the delivery of the desired volume of air at the assigned pressure. At 30 pounds pressure, air flows through an orifice in a thin plate at the rate of 525 feet per second. Then for the plant as above described, for the issuance of 5 cubic feet of free air per minute under a compression

of 3 volumes in 1, is $\frac{5}{3 \times 60} = 0.2777$ cubic feet of compressed air per second, and $\frac{0.2777}{525} = 0.000529$ of a

square foot area. Then $0.000529 \times 144 = 0.076176$ of a square inch. Then enlarging for the coefficient of efflux, the orifice should be ⅛ inch diameter, with a valve back of it to shut off the air flow when required. Means should also be provided for blowing off any water that may condense in the air pipes or storage tanks by the cooling of the air after compression.

With proper care and a moderate outlay the system of cold storage by compressed air becomes a simple, efficient and economical adjunct to the living comforts of every home in a warm climate not blessed with a nearby ice-making plant.

In sorting over the letters from various parts of the world, 197 different ways of spelling "Chicago" have been found; among them "Jagjago," "Hipaho," "Jajigo," "Schecchacho," "Hizago," "Chachicho," and a scholarly resident of Finland indulges in "Zizazo."

same amount of heat may be eliminated from the expanding air as was accumulated by its compression, and from which a large cooling efficiency may be obtained.

The graphic diagram has been made to show at sight the cooling effect produced by the free expansion of dry air from various pressures and from the normal temperature of sixty degrees Fahrenheit. The conditions of air expansion for any natural temperature of the stored air may be found by simply adding the difference to the expansion column when normally above sixty degrees, or subtracting when below sixty degrees. Thus, in an atmospheric temperature of eighty degrees, the cold produced by expanding from twenty pounds pressure would be minus sixty-seven degrees instead of minus eighty-seven, as shown in the diagram. From thirty pounds pressure and ninety degrees atmospheric temperature, the cold air of expansion would be minus one hundred and eight degrees instead of minus one hundred and thirty-eight, as in the diagram; thus for any atmospheric condition of temperature and pressure, the theoretical condition of cold by expansion may be known by simple inspection of their several relations as shown in the diagram.

The diagram shows much that is interesting in regard to the general conditions and effect of air compression and expansion. It will be seen that the column of pressures on the right corresponds with the

for cold storage and preservation of food, a large departure from the theoretical figures for the degree of cold by air expansion must be made on the favorable side for success.

The absorption of heat from the walls of a cold room, the cooling of a large body of air in the room and of food products stored and the greater loss from frequent opening of a cold room for the removal and refilling, with the natural leakage of cold air around the doors, makes the margin of loss in cold air production a larger one than at first appears when brought into actual use.

The amount of specific heat contained in a given volume of air is about ⅓ of the amount contained in the same volume of water for any number of degrees change of temperature at ordinary climatic temperatures, so that there is a large margin between the volume of cold air required to cool a room filled with air only and the volume required to cool a room filled with fruit, vegetables, milk, butter or meat containing from 50 to 90 per cent. of water and of which the solid parts also have a far higher specific heat than air.

This property of water loaded food accounts for the time required to cool a loaded cold storage room over the time required for cooling an empty one, as well as the necessity for so packing the material of storage that the cold air can circulate freely and bring every