

end of the expansion the piston, *E*, is at the bottom of its stroke, as is also the piston, *D*.

**Fourth Cycle. Exhaust.**—The piston, *E*, forces the spent gases through the ports, *B*, and into the cylinder. The valve, *S'*, is open, and the gases are expelled into the atmosphere. At the end of the exhaust, the piston, *D*, closes the ports, *B*.

**First Cycle. Admission.**—While the admission is beginning in *C* through the valve *S*, the piston, *D*, finishes expelling through *S'* (which is open) the burned gases that it contains.

**Second Cycle. Compression.**—The compression then begins at *C*. The piston, *E*, compresses in its cylinder, *C*, the atmospheric air aspired through *S*, and during this operation the cylinder, *A*, which continues to increase in capacity owing to the movement of the piston, is put in communication through the valve seen at *S''* in the plan, with the compression chamber, *C*. A portion of the compressed air, therefore, passes through *S''* and traverses the nozzle, *O*, at the same time that an injection of gasoline, forced by the pump, *P*, occurs through pipe, *T*.

The nozzle therefore performs the function of an atomizer, and the gasoline escapes in a thin jet which is seized by the strong current of air furnished by the compression and distributed all around the jet.

The object of the atomizer is therefore to form a homogeneous mixture.

**Third Cycle. Expansion.**—As soon as the period of compression is finished in *C*, the valve *S''* closes, an explosion occurs in *A*, and the uncovering of the ports *B* by *D* takes place. The heat produced, due to the high temperature of the explosion, is communicated to the mass of compressed air at *C*, and the expansion and third period with which we began our examination of the cycle begins again.

Thus, as may be seen, the object and *raison d'être* of the small cylinder, the dimensions of which are determined by calculation, reside in the function of its piston, *D*, playing the rôle of a slide valve and serving to separate the explosive mixture rich in hydrocarbons from the air, which is non-combustible up to the time of the explosion; the mixture being formed immediately afterward by the opening of the ports *B*, which put in communication, through the annular space between the two explosion chambers, the interior of the two cylinders. This separation permits of diluting, so to speak, the rich burned mixture in a quantity of air or inert gas such that, without the separation, no explosion could have taken place.

As can be seen from the diagram, cooling by a circulation of water is made use of only around the valves in order to assure their preservation, and it may, perhaps, be done away with later on.

The operation with gears, although simpler, presents some drawbacks, such as noise, the easy breakage of a tooth by the shock due to an ill-timed explosion, the play between the teeth of two gears in mesh, etc. So the idea occurred to unite the motor shafts by connecting-rods, despite the slight complication in operation that results therefrom.

#### FOUR-CYCLE OPERATION WITH CONNECTING RODS UNITING THE TWO MOTOR SHAFTS.

In this mode of operation, the crank, *M*, makes a number of revolutions equal to those of *M'*, although it is set at an angle of about 90 deg. in advance.

**First Cycle. Aspiration.**—The small piston, *D*, at its half stroke, uncovers the ports *B*, and the air drawn in by the large piston, *E*, passes through the valve *S'* (which has become an automatic, suction-operated valve), and through the orifices *B*.

**Second Cycle. Compression.**—The small piston, *D*, at its half-stroke, closes the orifices *B*, and the valve *S'* opens at the beginning of the stroke in order to permit of expelling through the valve *S'* (which afterward closes) the surplus air drawn in. The compression is afterward finished between the two pistons, the cylinders of which are put in communication by the open valve *S'*; but it is only at the end of the second half of the stroke, when the small piston starts to return to its initial position, that the injection of gasoline occurs through *T*.

**Third Cycle. Explosion.**—The valve *S''* closes, and the explosion in the small cylinder and the uncovering of the orifices, *B*, occur. The hot gases of the small cylinder heat the cold gases of the large one, and the expansion takes place between the two pistons.

**Fourth Period. Exhaust.**—The small piston, *D*, closes the orifices, *B*, again; and then, during the first part of the stroke, the burned gases are expelled from the small cylinder *A*, either into the atmosphere through an additional valve, or, if it be desired to dispense with the latter, by sending them through the valve *S''* (open for a sufficient length of time) into the large cylinder, *C*, whence they escape through the open valve, *S*, which acts as an exhaust valve. During the second part of this stroke the small piston begins to aspire fresh air through *S'*, while the other valves, *S''* or *S'''*, are closed, and the expulsion continues in the large cylinder, through the valve *S*, which remains open.

#### TWO-CYCLE OPERATION.

The two-cycle operation is more advantageous, since it reduces the mechanical frictions for the same power, gives one explosion per revolution, and doubles the power of the motor, while greatly reducing the loss due to the heat units carried along by the gases expelled into the atmosphere. It requires, on the contrary, the use of a connecting-rod uniting the two motor shafts. In this operation, the small piston, *D*, is always in advance of the larger one, *E*, by about

half a stroke. This advance is obtained by setting the crank, *M'*, about 90 deg. ahead of the crank, *M*. Moreover, both of these cranks make an equal number of revolutions during the same time. Finally, the valve, *S''*, which puts the two cylinders in communication at the moment of compression no longer exists, but is replaced by another valve, *S*, which puts the small cylinder alone in communication with a small additional compressor designed to furnish it with the pure air necessary to the explosion, and that, too, always through the intermedium of the nozzle, *T*; while the gases of the expansion in the large cylinder, *C*, are again compressed in order to serve for the following expansion, after the expulsion of the excess alone of such gases, at the beginning of the compression stroke.

**First Cycle. Compression.**—The ports, *B*, of the small cylinder are closed during all this time. The small piston, *D*, during the first half of the stroke, expels through *S'* the burned gases in *A*, and during the second half sucks pure air compressed adiabatically through *S''*, into the additional small compressor. This hot air is carbureted by a jet of hydrocarbon (kerosene or petroleum preferably) delivered by the pump, *P*. The high temperature of this air, caused by its adiabatic compression, favors the vaporization of the fuel.

During this time the large cylinder expels through the valve, *S*, a portion of the gases which have just acted and are in excess, so that its compression stroke may be less than the expansion one. Then it compresses the remaining gases, cooled by an injection of water, in an exactly necessary quantity, in order that, during the compression, the vaporization of such water may prevent the gas of the large cylinder from sensibly exceeding 100 deg. C., but without any water remaining liquid after the compression is finished.

**Second Cycle. Expansion.**—During this stroke there takes place an explosion in the small cylinder, an immediate opening of the ports, *B*, a heating of the incombustible gases in the large cylinder, and an expansion between the two pistons.

During the second part of this cycle the small piston reverses its motion and closes the ports, *B*, again.

The complication of this motor is not what it seems, and, moreover, is amply compensated for by the saving in fuel that it effects.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from *La Vie Automobile*.

#### CARBON DIOXIDE.\*

By MYRON L. FULLER.

**Introduction of Liquid Carbon Dioxide.**—The quantities of carbon dioxide, or carbonic-acid gas, as it is popularly known, used in the production of carbonated beverages and for numerous other purposes has in recent years reached enormous proportions, and its production has given rise to a business of considerable importance. Up to about twenty years ago all carbon dioxide used was in the gaseous form and was mainly applied in the bottling and soda-water trades, the gas being in many instances manufactured, even by the retailer, by treating limestone or marble dust with acid. The inconvenience of this method, and especially the enactment of city ordinances against introducing the waste from the generators into sewers, led to a demand for a more convenient source, which was met in 1885 by the introduction by a New York firm of liquid carbon dioxide. In spite of its somewhat greater cost it worked its way into favor until there are now about 40 factories producing liquefied carbon dioxide in the United States, the annual output amounting to about 30,000,000 pounds.

**Sources of Carbon Dioxide.**—The calcination process in which magnesium carbonate in the form of the mineral magnesite is finely ground and roasted in iron retorts was formerly among the most common, and is still used to some extent. According to Minor the gas, which commences to evolve at a low heat, is allowed to go to waste until all air is expelled from the retorts, after which the heat is increased and the gas conducted to the gasometer. The process requires about 24 hours to complete.

Carbon dioxide is also obtained by treating magnesite, or limestone in the form of marble dust, with sulphuric acid. Still another method is to draw off by suction the carbon dioxide generated by fermentation in closed vats in breweries, the gas being subsequently washed and purified by passing through a solution of potassium permanganate. In Europe the carbon dioxide is most commonly obtained by passing the products of combustion from the burning of coke through potash lye, from which it is later expelled by heating under pressure. A ton of coke will yield on the average about 750 pounds of carbon dioxide. Another relatively recent method is the liquefaction of the natural carbon dioxide obtained from spring waters. This is described in detail later.

**Uses of Carbon Dioxide.**—With the introduction of liquid carbon dioxide the applications of the acid were greatly extended, although the use in beverages still remained the most important. A number of the purposes to which, according to Minor, its use has recently been extended are mentioned below in connection with its longer established uses.

**Manufacture of Carbonated Beverages.**—The quantity used in bottled beverages and in sodas sold from the fountain is enormous. Twenty pounds of liquid carbon dioxide are required to make 100 gallons of soda

water, a quantity not infrequently sold at a single store in a large city on a hot day, and the total quantity so used goes far to make up the thirty million pounds manufactured annually. Much of the remainder is used in bottling. In soda fountains and in filling siphons a pressure of about 180 pounds to the square inch is used, but in bottling 60 pounds is a more common pressure.

**Drawing Beer.**—The use of carbon dioxide to produce the pressure necessary to force beer or similar liquids from the point of storage to the taps is quite general and constantly increasing. The quality of the beer is much superior to that where compressed air is used for the same purpose, there being much less deterioration.

**Substitute for Secondary Fermentation of Beer.**—The use of carbon dioxide to replace secondary fermentation is rapidly extending because of the great saving of time, although it is claimed by some that the beer so produced is of inferior quality.

**Operation of Block Signals.**—Another modern and rapidly increasing use of carbon dioxide is found in the operation of block signals by the electro-pneumatic process. The details are as follows: When a train approaches the signal it short circuits a track battery, thereby opening a relay and closing an electrical contact point, which in turn causes an electro-pneumatic valve to open, provided there is no train on the block ahead. Carbonic acid gas at 54 pounds pressure is thus permitted to pass from a secondary tank, fed by a gas cylinder through a pressure regulator, to the semaphore casting, which, when forced up by the pressure, causes the blade to go from a horizontal or stop position to one of 60 deg., thus giving a proceed signal to the train.

**Extinction of Fires.**—The use of carbonic acid in the so-called "chemical engines" is very extensive and successful, but in most instances it has been found cheaper to produce the gas in the engine by agitating acid with some mineral carbonate than to use the liquid acid. The quantity of available gas, however, is much less under the present practice than it would be if the liquid form were used. The latter is especially applicable where the fire occurs in a confined space, as in the hold of a vessel, where it has many advantages over water, having not only greater powers of penetration, but also greater efficacy in subduing combustion. It has been estimated that 150 cylinders of carbon dioxide will furnish enough gas to extinguish a fire in every hold of a cotton steamship.

**Refrigerants.**—Carbon dioxide requires little space as compared with an ammonia-compressing apparatus, and because of less danger from its fumes in case of accidents, the absence of any tainting due to its odor, etc., it has many advantages over other forms of refrigerants on shipboard. It has been extensively used in Europe and elsewhere for this purpose and is coming into use in America, notwithstanding its greater cost. The possibilities of its use as a sterilizing agent and food preservative are also encouraging.

**Treatment of Logwood.**—The use of carbon dioxide in the extraction of dye from logwood tends to form a definite compound and to prevent decomposition, which formerly gave much trouble and detracted greatly from the efficacy of the dye. The coloring agents produced by the new process may be applied much more satisfactorily to cotton fabrics than before, the resulting shades being far more perfect.

**Therapeutic Uses.**—Many thousands of persons, including many who have crossed the ocean from this country, visit and are benefited by the various carbonated baths on the Continent. The internal use is also beneficial in many instances. We undoubtedly have in this country springs of equal medicinal value, which only require proper exploitation to place them with the European springs among the great therapeutic springs of the world.

**Production of Carbon Dioxide at Saratoga Springs.**—Although carbon dioxide occurs in almost every natural water, it is rarely present in quantities sufficient for commercial purposes. It is only at Saratoga Springs, New York, that practical use is made of it in the production of the liquefied acid.

Formerly the waters bearing carbon dioxide emerged entirely as natural springs, but as the demand for the waters increased wells were sunk to tap the waters at lower levels. Over 40 such wells, generally 6 inches in diameter and ranging from 30 to 600 feet in depth, have been drilled to secure the carbon dioxide gas, the total yield of which is estimated at about 20,000 pounds per day.

**Geologic Conditions.**—The wells at Saratoga are located on a plain of gravel and sand 50 to 100 feet or more in thickness. Below these unconsolidated materials are two limestones of diverse types separated by a fault passing beneath the town and having a bearing a little east of north. North of the town and only a short distance away are outcrops of crystalline rocks such as are characteristic of the Adirondacks. Beneath it and west of the fault is a hard massive bluish limestone known as the Beekmantown, while east of it are the thin bedded arenaceous Trenton limestones.

The wells yielding the waters bottled and sold for medicinal purposes start in drift along the east side of the fault, which they probably encounter at considerable depths and thus obtain their mineral waters. These wells carry much carbon dioxide, but rarely enough for commercial purposes and are seldom utilized as a source of the gas. Most of the gas wells are located south of the town and obtain their gas in part beneath a resistant clay bed which they encounter at 90 feet or less, and in part from the Trenton limestone at depths up to several hundred feet.

\* Extract from Mineral Resources of the United States, published by the U. S. Geological Survey.

For data regarding sources and uses the writer is indebted to Mr. John C. Minor, Jr., Chem. Eng., vol. i, 1905, pp. 212-218; for statistics of production to Mr. D. H. Newland, Bull. 93, New York State Museum, 1905, pp. 942-943; and for geology to memoranda furnished by Messrs. F. B. Weeks and E. C. Eckel.

**Source of the Carbon Dioxide.**—The gas at Saratoga appears to come mainly from the Trenton limestone. None is obtained from the Beekmantown beds west of the fault or from the crystalline rocks; and the numerous wells along the fault, while yielding much gas, do not, as was just indicated, afford it in commercial quantities. At Ballston Spa, a few miles south, carbon dioxide is obtained from the thin shales. The occurrence, though reaching a maximum at Saratoga, is by no means confined to this locality, gas being given off by the springs from the Trenton limestone and the Utica shales over a large area in this portion of the State.

**Origin of the Gas. Source in Limestones.**—The quantity of gas given off, amounting at Saratoga alone to 20,000 pounds daily, is far too great to be derived from the decomposition of carbonaceous organic matter, since the rocks contain little of such materials, and even the small quantity present does not occur in a form capable of affording carbon dioxide.

The giving off of carbon dioxide is characteristic of the closing stages of volcanic eruptions, but the gas is thought to come, perhaps, rather from the country rock with which the heated lavas have come in contact than from the magma itself. In the absence of heated waters or any other indication of recent igneous activity near Saratoga, there is little upon which to base the theory of derivation from such sources. The volume given off, even since the springs have been known, is far too great to have been derived from the stored waters from a magma long since cooled.

The only available sources capable of furnishing carbon dioxide in the quantities observed seem to be the Trenton limestone or the calcareous portions of the Utica shales of the vicinity. The fact that waters carrying an excess of this gas are obtained from these formations over a wide area, but are not found in other rocks, tends to substantiate this view. That the gas at Saratoga is obtained mainly in the vicinity of faults is probably due to the more favorable conditions for underground circulation at such points.

**Nature of Chemical Reaction Involved.**—Of the substances present in natural waters those which can most readily react with limestone to produce carbon dioxide are the organic acids, colloidal silica, and sulphuric and hydrochloric acids. There is little evidence of the organic acids in the Saratoga waters, the small amount of organic matter present being mainly in the form of free ammonia, with practically no nitrites or nitrates. The magnitude of the operation going on also tends to show the incompetency of such acids. With one exception there is a general absence of sulphates in any but the smallest quantities, so it is probable that sulphuric acid may likewise be ruled out as an agent in the production of the gas. Colloidal silica, especially at high temperatures, might react with the calcium carbonate of the limestone and form the silicate of calcium, thus liberating carbon dioxide. The process is a very slow one at ordinary temperatures, and if actually going on must be adjusted with a nicety almost surpassing belief, since all the waters are unusually low in silica. In the case of chlorine, however, which is present in the waters in great quantity, we have a possible indication of originally muriated waters, such as might be derived from recently injected igneous rocks. The chlorine may very likely have been derived, nevertheless, from the sedimentary rocks. The latter source of the chlorine is inherently much more probable than the former, yet it fails entirely to account for the free acid necessary to react with the limestones. On the other hand, there is no evidence of recent igneous activity which could account for the acid solutions.

There has been recently discovered,\* however, a volcanic plug a mile north of Schuylerville and about 20 miles northeast of Saratoga, which, from the scoriaceous character of the lava and the imbedded bombs, seems to have been formed when the surface had a level only slightly higher than at present and far below the level of the supposed early Tertiary peneplain in this region. If any weight is to be given to this physiographic evidence, it would appear that the eruption occurred later than early Tertiary and before the close of the later Tertiary period of peneplanation, during which period it is thought the general level from which the plug now projects may have been produced. It is highly improbable that solutions from this period of igneous activity have persisted in the crust to the present time, but the occurrence is suggestive of the possibilities of still later intrusions which may not, however, have reached the surface.

With the little evidence at hand and with the present knowledge of chemical reactions, it seems most likely that the carbon dioxide is being set free from limestones by the action of chlorinated waters, the only source of which, so far as known, seems to be igneous rocks. It is not at all improbable, however, that the gas is given off as the result of some process not yet understood or suspected.

**Production.**—The producers, owing to business rivalry, are not inclined to give information as to the quantity of gas obtained, but it is reported that a considerable proportion of the 20,000 pounds yielded daily is obtained from the drift into which it has passed from the underlying rocks. Only about half of this is recovered. The largest producers, therefore, are said to be the relatively shallow wells, 30 to 100 feet in depth, of which so many have been drilled south of the town. Of the rock wells, those south of the town yield the most gas, obtaining it at depths said to vary from 150 to 600 feet. The rock gas if found at all in commercial quantities, is generally encountered at the

junction of the argillaceous Utica shale just over the Trenton limestone. Many non-producing wells have been drilled.

The waters from the mineral wells in Saratoga are used mainly for medicinal purposes, although they all carry considerable gas. The following table shows the quantity of free carbon dioxide contained to each cubic foot of water as based on analyses.\* The waters were bottled at their source, and although there is probably some loss, the quantities are very nearly correct.

*Carbon Dioxide in Mineral Waters of Saratoga Springs, N. Y.*

[J. R. Haywood and B. H. Smith, analysts.]

| Name of Spring or Water. | Volume of Free Carbon Dioxide to Each Cu. Ft. of Water. | Name of Spring or Water. | Volume of Free Carbon Dioxide to Each Cu. Ft. of Water. |
|--------------------------|---|--------------------------|---|
|                          | Cubic Foot.   |                          | Cubic Foot.   |
| Vichy.....               | 0.255   | Seltzer.....             | 0.763   |
| Hathorn.....             | 0.075   | High Rock....            | 0.172   |
| Arondack.....            | 0.397   | Lincoln.....             | 0.403   |
| Geyser.....              | 0.182   | Chief.....               | 0.360   |
| Peerless.....            | 0.193   | Victoria.....            | 0.161   |
| Magnetic.....            | 0.034   | Carlisle.....            | 0.126   |
| Star.....                | 0.766   |                          |   |

**Compression of the Gas.**—From the wells, which are usually 6 inches in diameter, the water and associated gas, according to Minor, are piped to a separator, a large tank equipped with a 2-foot trap at the bottom, from which the water escapes, and with a pipe at the top leading to the gasometer into which the gas discharges. But little goes to waste except that actually in solution. From the gasometer the gas is drawn through calcium chloride driers to remove the moisture, after which it passes to the compressor, working generally in three stages, at, approximately, 60, 300, and 1,000 pounds. After a final cooling fixed weights of the gas are admitted into cylinders for shipment.

The cylinders are made of lap-welded or seamless steel tubing; the smaller cylinders are about 5½ inches in outside diameter and 4 feet long and are charged with 20 pounds of gas, while the larger are 8½ inches in diameter and 51 inches long and are charged with 60 pounds of gas. This is two-thirds of the water capacity. The bursting pressure of the tubes varies between 5,100 and 5,900 pounds per square inch in the case of the seamless tubes, and between 4,900 and 5,500 pounds for the lap-welded. All are tested to 3,700 pounds before filling. Since the pressure, even at 130 deg. F., is only 2,240 pounds, there is a wide margin of safety.

#### SYNTHESIS OF ALCOHOL AND THE METALLIC CARBIDE.†

M. ARACHEQUESNE reviews the long period in which organic chemistry was able to proceed only by analysis. It was the French savant Berthelot to whom belongs the honor of having produced the first organic synthesis, that of alcohol.

Four successive reactions were necessary: the first united carbon and hydrogen, producing acetylene; the second formed ethylene in presence of nascent acetylene and hydrogen. Afterward, by combining sulphuric acid and acetylene, sulphovinic acid was obtained; the latter product was decomposed in contact with water, and alcohol and sulphuric acid were obtained, a molecule of water being combined with the ethylene. The same series of operations is in use today by the Compagnie Urbaine d'Eclairage par le Gaz Acetylene.

By patient researches a mixture of oxides has been discovered, producing a carbide, which in the usual gas generators furnishes ethylene, thus uniting the first two operations.

To produce sulphovinic acid, the ethylene is driven through a kind of Woolf apparatus, of lead, containing sulphuric acid. In practice, it is still necessary to reconstitute the metallic carbide by passing anew into the electric furnace the oxides precipitated in the gas generator, and to concentrate the acid water to collect the sulphuric acid. It is then sufficient to pour the sulphovinic acid into water and distill the product, to separate the alcohol.

Different precautions have allowed the avoidance of the production of foreign bodies, such as acetic acid and cyanides. A mixture of alcohol and ether remains, which is easy to separate into its component. M. Arachequesne states that the alcohol thus produced industrially is made at low cost. To estimate the value of the ethylenized carbon which serves as a point of departure in this production, calcium carbide may be taken for comparison. The price of this is estimated to be less than 100 francs per ton; it must not be forgotten that this price is increased in France by the royalties of the Bullier patents. Experience has permitted estimating the consumption of the coke which furnishes the carbon at less than 200 kilogrammes per hectoliter of alcohol. Thus, with the expense of concentration of the acid a total is reached of 5.25 francs to 6.50 francs per hectoliter of alcohol, to which must be added the cost of the electric current.

It is evident that the economical production of artificial alcohol is not to be effected except where water power is available at a moderate price. Under these conditions the cost price of synthetic alcohol permits of bringing it into competition with alcohols of vegetable origin at a profit, especially for industries employing alcohol as a raw material, and in France in

\* Mineral Waters of the United States; Bull. 91, Bureau of Chemistry U. S. Dept. of Agr., 1905, p. 84-97.

† Résumé of a communication to the Société des Ingénieurs Civils de France by M. G. Arachequesne.

general, since this country is largely tributary to others for these industrial products.

M. Arachequesne notices other industrial syntheses which have been realized; that of benzene, that of acetic acid, that of acetic ketone, and different derivatives of ethylene, as chloroforms, iodoforms and bromoforms. He cites the experiments of M. Walther, who has obtained the synthesis of glucose, those of a German company which has realized the fixation of atmospheric nitrogen, and the synthesis of camphor, expressing in conclusion admiration for that powerful instrument, the electric furnace, which has contributed to the entrance of chemical synthesis into the industrial domain. It will permit of obtaining artificially a great number of products, now extracted at much expense from organic substances.

#### THE PHOTO-EXPRESS.

THE process contrived by M. Ponsin-Druart for the rapid printing of photographs is well known and its successful use gives very fine effects. However, many photographers prefer copies obtained by photographic printing. These, it is true, cost a little more, but on the other hand it is not necessary to have special knowledge or training to obtain good results. The amateur will generally be able by this means successfully to multiply his copies, and the professional, too, will usually be able to satisfy the most exacting of his customers.

But photographic printing has two drawbacks. As we have said, it is a little more expensive. This may be disregarded when but a few copies are taken, and is also not to be considered by the professional, who does not allow the residues of his operations to be lost or wasted. The second is, that the printing demands more time on account of the successive operations for obtaining the copy. This is more serious in professional practice than for the amateur, with whom time is not always money. An inventor, M. Canet, has avoided this inconvenience by a printing apparatus to which he has given the name of "photo-express." The apparatus has been the subject of a communication to the French Photographic Society.

The apparatus, designed for the printing of gelatinobromide papers, postal cards, etc., has been constructed to avoid the loss of time resulting from the manipulation of the ordinary frames, and to permit continuous work. It may be compared with that of a printing press and has a lantern body, containing a petroleum lamp. This source of light is sufficient for securing a good proof of a normal negative in three seconds. In front is a shutter mounted on one axis with the plate bearing the negative, and at right angles to the same. The first permanently shades the light by a red glass. The plate consists of a transparent glass. The two glasses, moving on the same axis, are kept in their normal positions by a counterweight, so that the red glass closes the apparatus hermetically, while the white glass is placed horizontally before the operator, between the two metallic supports which receive the sheets of sensitive paper; that on the right for those to receive the impression, that on the left for those which are printed. Above the white glass supporting the negative, is a metallic shutter lined with felt, which, on being lowered upon the negative, keeps in place the paper or postal card which is to receive the impression.

When the lamp is lighted and the flame adjusted at an average height, the negative is placed on the white glass; it is fastened with two or three gummed strips. The sheet of bromide paper is afterward placed upon the support on the right, which is slipped onto the negative, provided in advance with guiding marks. The metallic shutter is brought down; the pressure exercised raises the counterweight. The arrangement turns on itself; the obturator (red glass) ascends on the inside against the upper wall of the apparatus, while the white glass takes its position and thus allows the paper to receive the impression. It is sufficient to keep it in this position for about three seconds for a normal negative. When the pressure ceases, the negative ascends of its own accord to its normal position, while the obturator closes the apparatus.

To give a better idea of the simplicity of the movement, it may be compared with that occurring on closing the cover of a desk, which would afterward automatically rise under the action of a spring. It is sufficient, then, to slide the printed paper or card upon the left support, to take another on the right, and thus to proceed anew. Three hundred copies can be readily withdrawn in an hour. In the course of the manipulations necessary in a dark chamber, the operator obtains sufficient illumination from the red light emanating permanently from the apparatus itself. The development of the copies is afterward conducted as usual.

The photo-express is quite simple in construction, as well as strong and durable. There are different models; large ones for professional photographers; smaller for amateurs, who wish to multiply copies of less importance, postal cards for example. But all are made on the same principle, and all work with the same certainty.—Translated from Cosmos.

**Soldering Grease.**—In a fairly large receiver melt together over a gentle fire 500 parts of olive oil and 400 parts of tallow; then pour into the mixture slowly, while stirring, 250 parts of powdered rosin; let the whole form a broth. Cool, and add 125 parts of a saturated solution of sal-ammoniac while stirring well. When cold, it is ready for employment.—Les Corps Gras Industriels.

\* Woodworth, J. B., The Northumberland volcanic plug; fifty-fifth Ann. Rept. New York State Mus., 1903, pp. r17-r24.