the main line relay tongue had been carried over, the selecting relay attached to that segment would have received an impulse to take it against its back-stop. Now, however, this selecting relay will receive a current through its coils in a reverse direction to what it would have received had the main line relay tongue continued to vibrate. Its tongue will, therefore, be thrown against its contact point, and will remain there until the trailer has made a complete revolution. When the trailer returns to the segment to which the relay is attached, unless some wave is again cut out, the relay will receive an impulse which will return its tongue to its backstop again. Thus, waves which are cut out at the far end of the line are reproduced at the near end by the tongues of the selecting relays which correspond to the wave cut out, being thrown against their contact points, *A*, *B*, *C*, etc., and there remaining during one revolution of the trailer. As each of the four keyboards at the far end of the line operates a corresponding bank of 11 selecting relays at the near end, the depression of any key of the keyboard, which cuts out two waves, will cause two relay tongues in the bank corresponding to that keyboard to be thrown against their contact points. A practised observer could readily interpret the cutout wave signals sent over the line by merely observing the movements of the tongues of the selecting relays. Tongues 1 and 3 sent over might be interpreted to mean *A*. 1 and 4 to mean *B*. etc., through the 45 possible combinations given above. But in the present system these signals are automatically translated into ordinary figures and letters of the alphabet which are printed upon a sheet of paper eight inches wide. It now only remains to show how this is accomplished.

The page-printer, by which the 41 different characters are printed in type, comprises essentially a light type-wheel of steel, about 2 inches in diameter, on the circumference of which 41 characters are engraved. This type-wheel revolves continuously at the end of a horizontal shaft which turns synchronously with the trailer. A light paper carriage carries the paper fed from a roll beneath the type-wheel when new lines are made. Devices are employed for thrusting the paper forward to make lines, and sideways to space letters. Back carriage devices return the paper to a position where a new line of print is to start. A small printing magnet operates a hammer which strikes the paper up against the lower side of the wheel rim, at the moment when the character to be printed has turned to its proper position above the hammer. A set of four polarized relays, called "distributing" relays, serve the purpose of making contacts at proper moments for sending current to the printing magnet to print, to a liner magnet to line the paper, to a spacer magnet to move the paper sideways, and to a back magnet which allows the carriage to return the paper to the proper position when beginning a new line.

In keyboards of the latest page-printers, contacts are electrically made. Fifty-six waves are divided into four groups. Of the waves in each group eleven are used for the printing; one wave in one of the groups is used for finding the letter; and three waves, one taken from each of the remaining groups, are reserved for purposes of signaling. The signaling can be effected in a number of ways. Morse instruments, one at each end of the line, can be worked duplex at a slow speed. It is preferable, however, to place at each end of the line, in addition to the four page-printers, a small page-printer, both of which print simultaneously at the rate of fifteen words a minute each. While the eight printers of the duplex system are in operation with the transmission of telegrams, the two stations can correspond with each other regarding business of the office, for the purpose of correcting errors. The system may, therefore, be called, with propriety, a "decaplex" system. In the later machines an additional important feature has been embodied whereby it is rendered possible to record at the sending station all messages which are transmitted.

It is claimed that the octoplex system can transmit to greater distances without relaying than other multiplex systems hitherto known. It has been successfully operated under government tests over a line of 550 miles; it is anticipated that it will work perfectly without relaying between New York and Chicago. Methods were, however, devised by Prof. Rowland for automatically relaying the messages.

Whatever may be the various applications of the Rowland system, and they are many, the octoplex capacity can be distributed in any convenient manner, that is, in place of having 8 operators, and a speed of 40 words per minute each, the number of operators can be doubled and the speed of each halved; or any number of operators can be employed with the limitation that the aggregate speed of the apparatus shall not exceed that of the eight operators at 40 words. In cases where branch lines radiate from a central, these lines may be 300 miles or longer. Or in cases of slightly different apparatus, placed at the terminal of the branch, these branches may have any length up to the maximum of the system. Way station lines may have any length up to 300 miles.

In this description it has been attempted only to give a bare outline of the features of Prof. Rowland's remarkable invention. Much more might be said of the many ingenious devices used and the new mechanical features employed. Throughout the apparatus is the practical embodiment of beautiful physical principles and mechanical devices. One very important characteristic is the natural way in which the system divides itself into distinct units. If one unit becomes deranged, another may be immediately substituted without stopping the operation of the rest of the apparatus.

SUBSTITUTES FOR COAL IN HEATING AND COOKING.

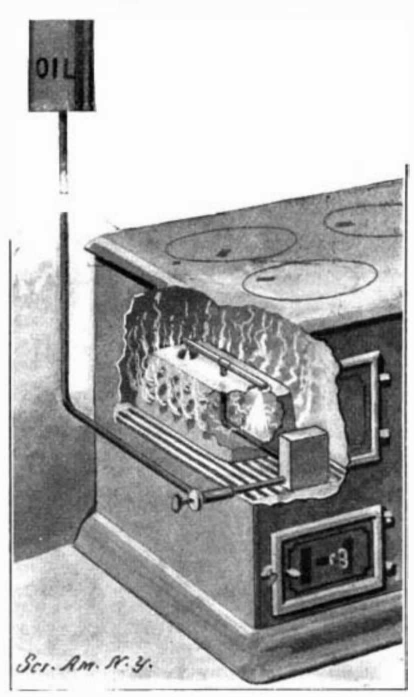
Although the strike in the anthracite coal fields is happily ended, it will take a few months to bring the supply up to the demands of the public, and consequently the price of hard coal is likely to remain at

A Type of White Flame Wick Heater.

a figure which will cause the majority of the "housekeeping" public to look around for a cheaper fuel than coal at anywhere from $9 to $12 a ton. The Scientific American has investigated the problem with results which are tabulated below.

1. Electricity can hardly be considered as a factor, for two reasons; first because but a very small proportion of the populace are situated so as to be able to have the current delivered to their houses, second because the cost of heating by electricity would be so very high as to preclude the possibility of its general adoption.

2. Soft coal, apart from its very high price and the difficulties in the way of getting it, requires such radically different treatment from hard coal in order to burn it, that its adoption as a substitute for anthra-



Range Oil Burner in Which the Oil is Fed by Gravity.

cite will necessarily be limited. In burning soft coal it must be remembered that, because of the much greater quantity of gas contained in it, care must be taken not to overload the fire box. In starting the fire, the grate must not be filled more than half full, and the fire must be replenished a little at a time. Air must be permitted to reach the fire from above as well as from below, and this may be accomplished by opening the broiling door or by slightly opening one of the lids at the back of the stove.

Owing to the large amount of unconsumed carbon which passes into the chimney, the latter will require careful attention, since the flues—at least in modern houses—are usually built for the burning of hard coal, and being of rather small area, they are very likely to become choked with soot. If the chimney should catch fire, the fire may be quickly extinguished by throwing a handful of common roll sulphur upon the glowing coals in the grate, closing down all the openings to the stove and covering the top of the chimney. The gas produced by burning sulphur—sulphur dioxide—does not combine with carbon, and therefore the fire in the chimney will be quickly put out. The chimney must be kept closed up until well cooled.

Chimneys which are provided with a hole at the bottom for cleaning purposes may be easily cleaned by dropping a pailful of pebbles down from above. These carry most of the soot down with them to the bottom, whence the matter is easily removed. The main precautions to be observed are to maintain a moderate fire, and to put on only small quantities of coal at a time.

3. Gas seems but a broken reed to lean upon, since the companies are utterly dependent upon the coal supply. Moreover, for heating a house from a basement furnace gas is very expensive. A talk with a representative of one of the largest gas stove manufacturers brought out the fact that when used in a hot-air furnace—a furnace by the way *specially* constructed to burn gas—it would cost as much to heat a house by gas as it would to heat it with a coal furnace burning coal at $20 per ton, and this, taken in connection with the cost of installation of the special furnace, would preclude the adoption of this means of heating to any appreciable extent.

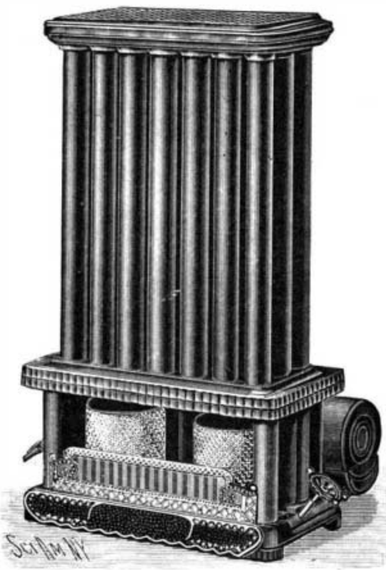
The economy which the gas cooking stove exhibits when compared with an ordinary range is entirely dependent upon the fact that in cooking with the gas stove nearly the whole of the heat produced by the gas is utilized, whereas with the range much of the heat produced is used to raise to a high temperature a large mass of iron; further, a fire once started in a range must burn for a considerable time after one is through cooking, while the consumption of fuel in the gas stove ceases directly you are through. It will therefore be quite evident that though the range burns by far the less expensive fuel, such a great proportion of the fuel energy is wasted that the gas stove is able to show an economy of operation just as long as the heat is required concentrated upon a particular place, and as long as the time during which the heat is actually required is comparatively small. The problem of house heating does not, however, conform to either of these conditions. In this case the heating of a large mass of metal is a positive advantage, as it gives a greater radiating surface, and since the heat must also be constantly maintained it is quite evident that the range, using as it does the cheaper fuel, is the more economical.

4. Oil stoves being entirely independent of the coal supply for the production of their fuel, naturally present a more promising field for investigation than anything we have thus far considered. They may be roughly divided into two classes; first, those which use a wick, and burn with a white or yellow flame, and second, the wickless or blue flame oil stoves. The latter are to be recommended as the more efficient heaters. An understanding of the principles of combustion will make this last point clear.

The process of combustion is in a chemical sense nothing more than the union of the oxygen of the atmosphere with some material for which it has such an affinity or attraction that the union is accompanied with light and heat. Now, kerosene is composed largely of two substances, hydrogen and carbon, for both of which oxygen has an attraction, though hydrogen combines at a much lower temperature than does carbon.

In lighting an ordinary kerosene lamp or wick oil stove this is what takes place: You apply a match to the wick, which is saturated with kerosene; the heat vaporizes a little of the oil, the hydrogen in the oil combines with the oxygen of the air, and the heat produced by this union heats the carbon of the kerosene white hot, and thus we get the familiar whitish-yellow flame of the kerosene lamp. The carbon does not, however, thoroughly combine with the oxygen, and in consequence a great deal of the heating possibilities of the flame is lost, though the flame serves as a fair illuminator.

In the blue-flame oil heater a different condition of affairs exists. The kerosene, which is stored in a reservoir, is permitted to flow slowly into a vaporizing device, from which it passes to a burner. In one of the stoves shown the vaporizing device is a circular trough, made of cast iron, which is heated to a very high temperature. This vaporizes the kerosene and the vapor thus produced is compelled to pass between two walls of red hot metal while at the same time heated air is caused to act upon it. The temperature to which the vapor is raised by this means is so great that *both* the hydrogen and carbon are compelled to combine with the oxygen, and, the united energy of combination of hydrogen and carbon in combination with oxygen being greater than that of hydrogen and oxygen in combination without the carbon, the flame is much hotter. Since the carbon of the kerosene is completely burned

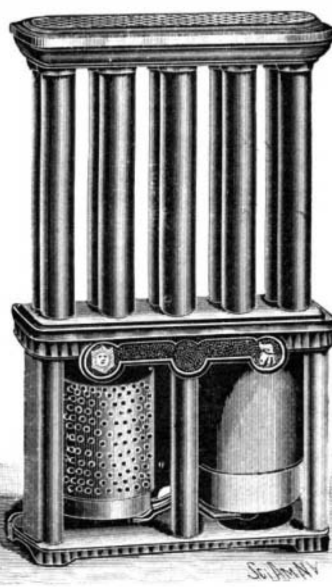


Blue-Flame Wickless Heating Oil Stove.

instead of being merely heated white hot, there is but little illumination with this flame.

The wickless stoves burn about 22 hours per gallon of kerosene per burner.

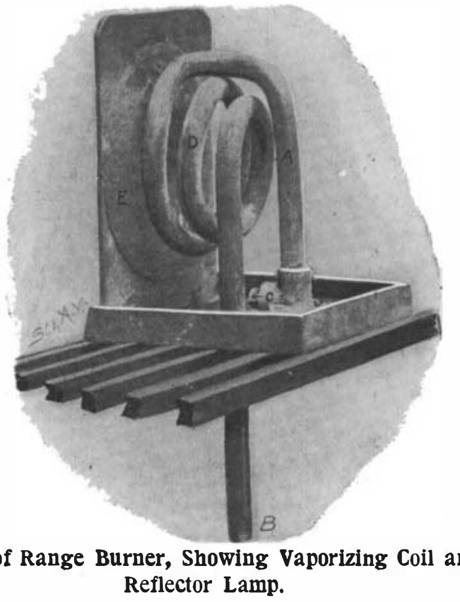
In buying a blue-flame oil stove care should be taken to secure one in which provision has been made to avoid "flooding" the burner. The simplest method of attaining this result is shown in the accompanying sketch. In this the main reservoir—which by the way may be detached from the stove and filled while the stove is in action—is so arranged that the opening of its valve dips just below the surface of the oil. When



Another Type of Blue-Flame Stove. Radiators May be Removed and Cooking Section Used.

the consumption of oil by the burner causes the level of oil in *M* to fall far enough to unseal the valve of *J*, oil rushes from *J* into *M* until the level is restored. In actual practice the working is so delicately adjusted that the oil comes from *J* a drop or two at a time, so that the level in *M* is practically constant; and since this level is below the upper edge of the oil chamber in the burner there is no possibility of an overflow even though the valve *Q* be carelessly left open.

There is one type of oil burner which under present conditions promises to have considerable influence upon the situation. We present an illustration of two



Detail of Range Burner, Showing Vaporizing Coil and Reflector Lamp.

of this type. One of these has a burner which is intended to be placed directly in the firebox of a range or furnace with a view of acting as an economical substitute for the ordinary coal fire. The burner, which is made in Philadelphia, has been in use in that city for sufficient time to demonstrate its worth. An expert with whom the writer talked declared that this burner was one of the best he had seen tried during the whole of an experience of ten or twelve years. The burner consists of a coil of ⅝-inch outside diameter iron tube affixed as shown in the adjoining cut, to a cast-iron trough. The vertical plate *E*, thickened where the flame strikes it, is so placed that the flame impinging upon it is reflected back on the coil. There is an exceedingly fine hole (No. 70 drill gage) through which the vapor from the kerosene is forced.

The burner is placed in the range so that the supply pipe *B* is vertical with the inlet downward, the outlet being connected by an iron pipe to a tank in which kerosene is stored under an air pressure of 3 to 10 pounds per square inch. The oil supply to the burner is regulated by a needle valve.

To start the burner in operation the needle valve is opened, upon which, the pressure in the oil tank forces kerosene into the coil, finally forcing a fine spray from the hole at *A*, and this oil dripping from the turns of the coil falls upon a sheet of asbestos, which is in the trough, and is soaked up. The needle valve is then closed and a match applied to the asbestos. The oil in this, catching fire, heats the coil and in a short time—perhaps 60 seconds—the coil becomes so hot that the kerosene in it is vaporized and forced in this condition through the hole at *A*. Catching fire as it issues, it produces an intense heat which impinges on the plate *E* and the turn of the coil. The coil thus becomes exceedingly hot, and as the needle valve is again opened a fresh supply of kerosene flows into the coil to be converted into vapor. Thus the flame is maintained. The burner owing to the very small hole used burns but little kerosene—about 1 gallon in 10 hours at 10 pounds pressure. Five pounds pressure is, however, ample for cooking stove work. Air pressure is obtained by means of a small pump attached to the reservoir, and the amount is indicated by a gage.

We also present illustration of a blue-flame burner adapted for use in the firebox of an ordinary kitchen range, which is similar in principle and general operation to the burner just described, except that the air-pump is dispensed with, and the pressure necessary to feed the oil is obtained by placing the tank of oil at a sufficient height above the burner to secure a flow of the oil by gravity. The oil is led through a needle valve which is placed just outside of the fire door, into a small iron rectangular box placed just within the fire door, where it is vaporized by the heat of the burner. From the vaporizer a pipe leads the vaporized oil to a length of horizontal pipe which extends, as shown, above a perforated cast iron box. At the two ends of this horizontal pipe and on its under side are two fine pin holes, through which the vapor issues in a fine jet and burns with the characteristic hot blue flame. The force of the jet drives the hot flame down through a couple of inch-and-a-half holes, located in the top of the iron box immediately below the jets. The flame and hot products of combustion fill the perforated box and pass out through the perforations, raising it to a red heat, and producing a sufficient amount of heat for the general cooking purposes of the stove.

To start the stove it is only necessary to thrust two pieces of ordinary newspaper into the holes in the box, open the needle valve and allow the oil to drip upon the paper. When the latter is saturated, it is lighted by a match, and the heat of the burning paper will in a few minutes vaporize the oil in the pipe and start the regular blue flame action of the burner.

Sawdust Fuel Briquettes.

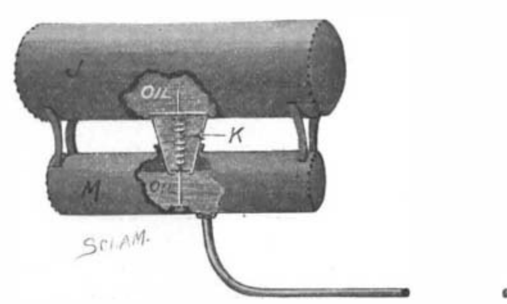
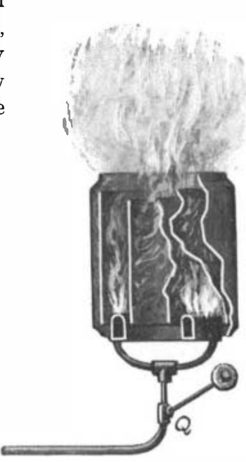
Sawdust in cake form appears to have been used as fuel in Germany with rather promising results. United States Consul A. L. Frankenthal, writing a short time ago from Berne, Switzerland, says that the sawdust cakes are octagon-shaped, 6½ inches long, 3½ inches wide and three-quarters of an inch thick, weighing about half a pound each. In the district surrounding the factory where these cakes were made the schools were heated by them, the combustion leaving very little ash and proceeding without a large flame. No binding ingredient is said to be used, the sawdust being simply dried and pressed into the desired briquette shape, and owing thus to the absence of tarry or oily substances there is no smoke in burning. The weight of such a briquette indicates the heavy pressure under which it takes its shape, and the edges look like polished oak; in fact, it is heavier than a piece of hardwood of the same size. The demand created by the popularity of the fuel exceeded the supply of sawdust obtainable in the vicinity of the factory, and shiploads were, therefore, procured

Blue-Flame Burner, Showing Cast Iron Trough, Regulating Valve, and Cylindrical Case.

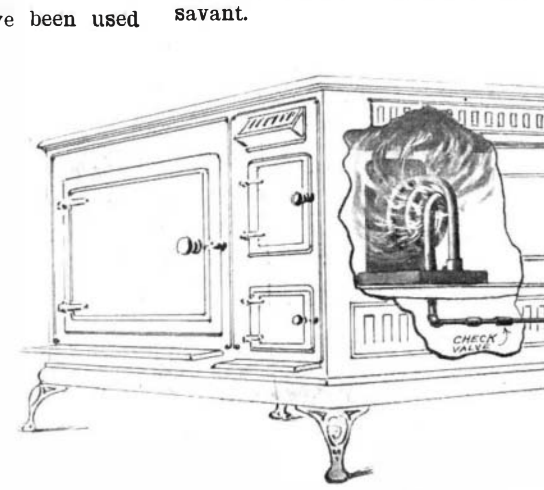
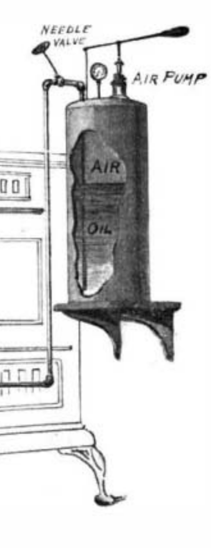
from Sweden and cartloads from distant manufactories. Sawdust, which previously could be had for the asking, commanded a market price as soon as it was known that a certain factory could make use of it. Even then it was profitable to manufacture the briquettes; but, unfortunately, the factory was destroyed by fire and operations came to a standstill. Making sawdust briquettes of this kind would, therefore, seem to be worth inquiring into further.

A Statue to Pasteur.

On August 5 a statue erected to the memory of Pasteur was unveiled at Dolê, the birthplace of the great chemist. The following account of the ceremony is given by the French correspondent of the Chemist and Druggist: Nineteen years ago, on July 14, 1883, the Doloise municipality commemorated the fact by placing a marble slab on the modest house where he was born on December 27, 1822, in the Rue des Tanneurs, now called Rue Pasteur. For the inauguration of the statue the townspeople had made extensive preparations, and all the local notabilities, including the members of Parliament, were present. The government was represented by M. Trouillot, Minister of Commerce, who made the distribution of medals and decorations that is customary here on such occasions. He afterward proceeded to the ceremony of unveiling the monument, and made an interesting speech, in which he traced the life of Pasteur. The Minister referred to it as an incessant struggle against death and suffering, which ended in victory for the savant.

Detail of Automatic Oil Feed and Blue-Flame Burner.

Range Burner in Operation, Showing Oil Tank and Air Pump.