4,000 horse power each, the first to be running next November, and the second by January, 1903. The Westinghouse Machine and Manufacturing Company, of Pittsburgh, have made gas engines of 1,500 horse power, and are prepared to build sizes up to 3,000 horse power, either horizontal or vertical.—Journal of the Society of Arts.

A POWER MILK SEPARATOR.

A NEW form of separator was shown by the Crown Separator, A2, Southwark Bridge Road, S. E., at the recent Carlisle Show. The novelty lies in the bearing, for there is only one. In the center, at the base, there is a fixed "dead" spindle A, and over this is a sleeve B which runs on five sets of balls. It will be seen that the ball-races are set at about an angle of 45 degrees, so that they form both thrust and side bearings. The arrangement can be easily followed in the engraving. The lubricating arrangements are very complete. The oil drops in at the side, passes up the center spindle, overflows into a hollow spindle, is then thrown out by centrifugal force, and thoroughly covers all the rotating parts. Finally, it escapes, and can be collected. The disks C in the bowl are of a new form. This machine runs very easily, and from its construction stands lower than most separators, so that it is easy to get at.

The principal feature in the dairy this year is the extended use of pasteurizers for the treatment of milk before separation. As constructed by the Dairy Supply Company, Limited, Museum Street, London, this apparatus consists of a vessel, through which the milk runs, surrounded by a steam jacket. As the steam comes into contact with the cold surface it, of course, condenses, and forms a layer of water which runs down the surface, and acts as a non-conductor of heat, so that it materially interferes with the efficiency of the pasteurizer. To overcome this a series of rings are fastened in the steam chamber, which divert the condensed water and cause it to drip to the bottom, bringing the hot steam into direct contact with the whole of the surface. To keep the milk in constant motion, so that it shall not suffer from local heating, horizontal rotating plates are used upon the stirrer in place of arms, which have hitherto been used. Experiments show that with the old style of apparatus there is a great inequality in the heat of the milk from the center to the circumference. The horizontal stirrers prevent the milk rising except by passing through a narrow opening in the heated surface, and thus insure all the milk being equally heated and remaining in the pasteurizer for the proper length of time. The stirrer is driven either by a belt or by a small engine. After raising milk to a temperature of about 180 degrees in pasteurizing, it has to be cooled. For this purpose the Dairy Supply Company use an interchanger. This receives the hot milk after it has left the pasteurizer and the cold milk on its way to the pasteurizer, the two flowing in opposite directions, the heat passing from the hot milk to the cold, and thus being economized.

Messrs. R. A. Lister & Co., Ltd., Dursley, show several steam pumps for elevating milk, the valves of the steam cylinders being actuated by steam admitted by ports controlled by the main piston.

RESEARCHES ON ARGON AND ITS COMBINATIONS.

By M. BERTHELET.

THAT chemical combinations of this element exist in nature cannot be doubted, in view of the existence of various ores which disengage the gas under the influence of acids. The absorption of argon by benzene and by carbon sulphide, submitted to the influence of the electric effluvia under the special conditions I have already described, engenders solid compounds, stable cold, of which the pyrogenous decomposition reproduces argon itself, as I have demonstrated by thorough experiments. It appeared to me advantageous to pursue the subject on more numerous samples and to endeavor to give a more definite character to the argonides, that is to say, the derivatives of hydrocarbonated compounds. These derivatives are obtained by the same processes that give rise to the electric combination of nitrogen with the most varied organic principles.

The experiments I will describe have been conducted on a new sample of argon which Lord Ramsay has kindly furnished me. This sample was contained in a well-closed glass bottle. It occupied 650 cubic centimeters of space at ordinary temperature and pressure, or 650 cubic centimeters reduced to the dry state at 0 deg. and 760 millimeters of pressure. Unfortunately it was not pure. It contained 30 per cent of nitrogen free from oxygen, as I have ascertained by three tests.

In the first two the nitrogen was absorbed, combining with oxygen in presence of concentrated potash, under the influence of a series of strong electric sparks. In the first instance the reaction continued for 15 hours, giving rise to an absorption of 30 hundredths of the initial mixture.

In the second case the operation lasted for 24 hours, with absorption of 30.6 hundredths.

The third test was effected by causing the effluvia to act on a gaseous mixture of argon and glycolic ether (ethylene pseudoxide), one of the best absorbents of nitrogen. The absorption was 29.5 hundredths.

Thus 455 cubic centimeters of pure argon were disposed of. The necessity of purifying the argon from its mixture with nitrogen has rendered the work troublesome, my apparatus not allowing of operating on more than 100 or 120 cubic centimeters of the mixture at my disposal, with the addition of the suitable proportion of oxygen (2 vol. per 1 vol. of nitrogen) or in all about 200 cubic centimeters. Each operation was executed in a large eprouvette over mercury, arranged as I have often described. It lasted from 15 to 24 hours with a continuous sparking current furnished by an inductive coil, fed by six storage cells, and regulated by a vibrating interrupter, which emitted several hundred sparks per second.

By reason of these obstacles, I have not pushed my investigation as far as I had at first projected. However, the facts I have observed add a number of points to the knowledge previously existing on the properties of argon and on the action of the effluvia.

My inquiries have not been affected by any preconceived theoretic opinion. They may be thus enumerated: Experiments relating to the action of argon on different organic compounds, under the influence of the electric effluvia; special experiments on benzene; experiments on compound mercurial radicals; special experiments on carbon sulphide.

I have also experimented with electricity, acting by its tension alone, in a continuous way, that is, by the potential of 200 Leclanché elements, developing a tension of about 200 volts, maintained without interruption for three months.

I operated on a volume of argon between 5 cubic centimeters and 10 cubic centimeters. It is not advantageous to exceed these volumes in effluvia tubes, on account of the slight capacity of the annular space in which the action takes place.

The gases are measured at first over mercury in graduated tubes at a temperature and pressure exactly known, the gases being perfectly dry. Then they are transferred to the tube designed for the effluvia experiments; it is connected with a large coil of platinum or aluminium. The interior concentric tube is introduced into this—a tube terminated outside in the form of a reversed siphon, which is filled with sulphuric acid. The whole is brought from the large mercury

the reactions varying with the electric tensions, the temperature developed and various other circumstances.

I. EXPERIMENTS RELATING TO THE ACTION OF ARGON ON VARIOUS ORGANIC COMPOUNDS.

My experience leads me to divide the hydrocarbonated compounds on which I have operated into three groups: the fatty or saturated series, the benzenic series, various cyclic series. The mercurial radicals were studied by themselves.

I will commence with the fatty series, of which the negative results bring into greater prominence the positive results of the benzenic series.

In this case, as in the others, immediately after the termination of the reaction of the effluvia, the apparatus is brought over the large mercury vat and the small vat removed. The tube, of siphon form, is first removed, detaching gently the bubbles of gas which may adhere to it. In case of need, this tube may be allowed to lie in a larger eprouvette over the mercury, without leaving it for a moment in contact with the air; this allows of verifying very exactly the absence of adhering bubbles.

When the siphon tube is removed, the gas remaining within the enveloping tube may be poured out into a

"CROWN" POWER MILK SEPARATOR.

vat over a small porcelain vat filled with mercury and immersed in the large vat, in order to arrange in it the system of concentric tubes.

The platinum or aluminium coil is then put in connection with one of the poles of the induction coil, the other pole communicating with the sulphuric acid.

The rapidity of the effects depends on the diameter of the annular space, on the surface of the effluvia tubes, and on the electric tension. Strong tensions are to be avoided, as well as copious showers of fire, with the corresponding heat, which destroy compounds not very stable.

The Ruhmkorff coil employed for developing the effluvia is 40 millimeters in length, with an exterior Leyden jar. It is fed by three or six storage cells (6.3 to 12.6 volts). The distance of the sparks furnished by the coil and the condition of its employment (several hundreds of sparks per second) is regulated at 6 to 8 millimeters.

It is clear that the coil can furnish much stronger sparks, but at a reduction of the number of interruptions to ten or fifteen per second, which in these experiments would be less favorable.

The technique of this class of experiments is delicate and requires to be studied in advance as to nitrogen,

large eprouvette over the mercury with suitable precaution, in order not to leave any trace in the tube. From this it may be poured the second time into a graduated tube, and the remaining gas measured exactly.

As this gas at times contains hydrogen, carbon oxide and other combustible fluids, it is indispensable to complete the analysis by combustion. For this purpose a known quantity of oxygen is added, and it is decanted into a eudiometer. If it does not burn, a small quantity of a detonating mixture, measured accurately, is added to it, and saturation produced in the eudiometer. Then the remaining mixture is brought again into a graduated tube, measured, dried and the carbonic acid and the excess of oxygen absorbed, measuring them by differences with suitable precaution. Finally, the residue is measured, consisting of non-combined argon, a residue equal to the initial volume in the case of the fatty series, but less in the case of the benzenic series.

A. FATTY SERIES.

1. Ethylene and argon in equal volume, twenty-four hours. The mixture diminished in volume, but remained greater than that of the argon. The eudiometric analysis showed that the product was hydrogen mixed with a small quantity of formene, or of equivalent

ethane. With ethylene, there was no absorption of argon.

In the course of this experiment, performed under atmospheric pressure, no luminescence was visible in the day time. At night, a yellowish light first appeared, becoming bluish, in which the spectroscope could distinguish no distinct lines.

2. Glycolic ether and argon, twenty-four hours. The product consisted of hydrogen and formene. Glycolic ether or pseudoxide of ethylene is gaseous at the temperature of 20 degs. It is one of the best absorbents of nitrogen. There was no absorption of argon, and no luminescence in the day time.

The results were the same with *gaseous aldehyde, acetone, amylene, petroleum ether, propionitride and sulphocyanide of allyle*.

In the case of amillamine, there was a disengagement of nitrogen. The volume of the nitrogen was obtained by absorption with oxygen in presence of potash, and with the aid of a long series of electric sparks. In this case, as in the preceding, there was no absorption of argon, and no luminescence in the day time.

B. BENZENIC SERIES.

The course of the experiments and of the analyses was precisely the same. Contrary to what occurred in the fatty series, all produced a greater or less absorption of argon, the coil being fed with tensions from 6 to 12 volts.

The contrast was not less striking in the luminescence and in the spectral analysis. After some hours, that is, in consequence of a slow and progressive reaction between the argon and the argonic vapor, a continuous green luminescence, more or less intense, appeared in the day time. This luminescence was developed in the gases under atmospheric pressure, and without recourse to stronger tensions than those that have been mentioned. In nearly all cases it was visible in full day light.

The spectroscope distinguished the lines of argon, of mercury, of carbon and of hydrogen.

1. Benzene. It is necessary to eliminate at the close by eudiometric combustion the excess of benzene vapor.

Varying the conditions of duration, of tension, of relative mass, etc., in the different experiments the volume of argon absorbed amounted to 8, to 7, to 5, and to 3 hundredths of the initial volume of this gas respectively.

2. Toluene. Very distinct green luminescence in the day time, like that of benzene, with the same spectrum, although feebler, especially at the outset. The absorption of argon was after a few hours from 2 to 3 hundredths.

3. Cymol. Quite feeble diurnal luminescence. Absorption of argon, 6 hundredths.

4. Turpentine. The luminescence was first whitish, then greenish at twilight, the time when the daylight declines sufficiently to render the luminescence more manifest. Spectrum, similar. The volume of hydrogen disengaged was slight. The absorption of argon was 2 hundredths.

5. Methylphenic Ether. The diurnal green luminescence appeared at the end of an hour. It was quite beautiful, though feebler than that of the benzene. The spectrum was the same; the absorption of argon was 5 hundredths at the end of twenty-four hours.

6. Phenol. Very slight green luminosity, visible at twilight. The absorption of argon was 2 to 3 hundredths.

7. Benzoic Aldehyde. The same observation; absorption of argon, 1 to 2 hundredths.

8. Aniline. Green luminescence, feebler than with benzene; absorption of argon, 1 hundredth.

9. Phenyl Sulphocyanide. Slight luminescence, but plainly visible. Absorption of argon, 2 hundredths.

10. Benzonitride. Beautiful green luminescence, appearing rapidly. Spectrum well defined. Absorption of argon, 5.3 hundredths.

It appears that benzene and its derivatives develop with argon the characteristic diurnal luminescence, the intensity increasing with the increase of the vapor tension; the phenomenon being slight with phenol, benzoic aldehyde, and phenyl sulphocyanide; more marked with cymol and aniline, and especially striking with benzene, toluene, benzonitride and anisol. This luminescence corresponds with the absorption of argon, and is especially distinct with the more volatile bodies.

The contrast of these results with those furnished by the fatty series shows that there is a special compound peculiar to the benzenic series, that is, a phenyl-mercur-argon of feeble tension and limited in formation, both by the vapor tension peculiar to the phenylic compound which furnishes it, and by the complex conditions of its stability and dissociation.

It may be remarked that the compounds of the fatty series and those of the benzenic series have been compared in two parallel groups, responding to the same functions.

C. VARIOUS CYCLIC COMPOUNDS.

1. Furfurol. Absorption of argon uncertain; luminescence visible at twilight, with a special spectrum perceptible with the spectroscope.

2. Thiophene. Absorption of argon, 3 and 2.5 hundredths (two experiments). Greenish luminescence, visible at night; with special spectrum.

3. Pyrrol. Absorption uncertain; luminescence slight.

4. Pyridine. Absorption of argon, 2 hundredths (two experiments). Marked luminescence at twilight, with special spectrum.

II. EXPERIMENTS RELATING TO THE ACTION OF ARGON ON BENZINE.

1. Argon and liquid benzene of a volume equal to one tenth of the volume of gaseous argon, that is, in excess. The specific luminescence appeared at the end of two hours, the liquid benzene continuing to a certain extent, though in great part destroyed. After destruction of the vapor by detonation, the absorption of the argon was found to be 3 hundredths.

2. A few drops of benzene were added to the argon not absorbed, and the reaction of the effluvium was prolonged for thirty-six hours. The luminescence ascertained with new absorption, 4 hundredths. On continuing for seventeen hours without any addition of ben-

zine, the absorption increased only 1 hundredth, or, in all, 9 hundredths. It is seen that the absorption became manifest at the same time with the luminescence, and that it stopped at about a certain limit, which seemed to depend particularly on the relation between the argon and the tension of the vapor of mercury, and of the phenyl-mercur-argon; that is, on the tension of dissociation of the last named compound.

3. In another experiment the luminescence being already distinct for an absorption of 5 hundredths of argon, the limit was reached at about 7 hundredths; in still another, at about 8 hundredths. These limits appear to be connected with the electric tension of the effluvium in the annular space. The temperature developed in this space certainly exerts an influence. When it is too high the compound is destroyed, or, what amounts to the same thing, is not formed.

4. When all the benzene was destroyed, if the electric action was prolonged indefinitely, the luminescence at the end of a long time diminished and finally disappeared.

5. On operating with equal volumes of gaseous argon and of liquid benzene, that is, with a large excess of benzene, the luminescence had not appeared at the end of twenty-two hours, perhaps because the excess of liquid had retained the phenyl-mercur-argon in solution. The apparent absorption of argon rose, however, to 14 hundredths, the greater part of the benzene being polymerized. The absorption was in reality the sum of the two effects, the chemical absorption and the simple solution.

6. The green luminescence of the phenyl-mercur-argon, ceases at the moment when the electric current is stopped. If the operation is performed at twilight, the eye is certain to perceive for a moment a violet glimmer, which in its turn is effaced, leaving only the permanent yellow tint of the polymerized derivative of the benzene adherent to the walls of the effluvium tube. If the current is re-established, the green tint immediately reappears.

7. I had preserved over a mercury vat for three years, a sample of argon, regenerated at that time by the decomposition of the compound which it had first formed with carbon sulphide, then put in presence of benzene and submitted to the action of the effluvium up to the formation of luminescent phenyl-mercur-argon. The benzene had entirely disappeared at the time of the latter experiment.

No change having been made in the arrangement of the apparatus or of the materials, whether gaseous or converted, it seemed to me of interest to endeavor to reproduce the specific luminescence. Eleven hours were necessary for the effluvium to cause it to reappear, with its emerald light and distinctive lines. The electric action was suspended for eight hours, then recommenced; ten minutes were this time sufficient.

This experiment demonstrates that the phenyl-mercur-argon, reabsorbed by the benzenic polymer, and perhaps at length decomposed spontaneously, like ozone and oxygenated water, reappears when its constituent elements are submitted to the prolonged action of the effluvium.

III. EXPERIMENTS RELATING TO THE ACTION OF ARGON ON CARBON SULPHIDE.

1. Argon and Liquid Carbon Sulphide. Tension of current, 6.3 volts. Time, twenty hours at 22 deg. The absorption was 7 hundredths. The compound formed is soluble, of fawn color, without coaly mixture. By operating on this compound, as in my first experiment, a small quantity of argon was regenerated by the action of the heat, reproducing the green luminescence with benzene; that is, the characteristic phenyl-mercur-argon.

2. Another experiment operated under the same conditions at the end of six hours yielded 6 hundredths of argon. To effect the analyses of the gases, the method I have already indicated was followed, consisting in absorbing the vapor of carbon sulphide with a fragment of potash previously soaked in alcohol, and absorbing the alcohol vapor with concentrated sulphuric acid.

3. Argon and Carbon Sulphide. Similar experiment, the tension of the current being 12.6 volts. Time, 24 hours. A rain of fire was produced. The compound formed was blackish and coaly. There was no absorption.

4. This experiment, under strong tension, was repeated with a larger proportion of carbon sulphide. This also produced a coaly matter, with no absorption of argon.

5. The argon not absorbed in the last experiment received a new addition of carbon sulphide and was subjected to the action of the effluvium for several hours, the tension of the current being only 6.3 volts. The compound formed was yellow, not coaly. The absorption of argon took place as in the first experiment; the amount was 5 hundredths.

These observations revealed a circumstance which I had not noticed in my old experiments, namely, the necessity of not operating with very high tensions and heating, especially with carbon sulphide.

6. Argon 100 volumes; $H_2 = 175$ volumes; CS_2 liquid. In twenty-four hours all the hydrogen had disappeared. The absorption of argon amounted to 10 hundredths.

7. Argon with 0.1 cubic centimeter of mixture of liquid carbon sulphide and benzene of equal volume. The absorption of argon was 9 hundredths. The product, decomposed by heat at the dull red, regenerates various gases, as the benzenic derivative does.

I have sought to define more precisely the relation which exists between the fixed argon and the converted carbon sulphide. I have thus found the following relations between the volumes of the gas absorbed and of the gaseous carbon sulphide combined under the prolonged influence of the effluvium: $2CS_2$ fixes H_2 ; $4CS_2$ fixes Az_2 ; $34CS_2$ fixes (argon).

In all cases a solid compound is formed, amorphous, of fawn color, polymerized. But it cannot be affirmed that this compound is not formed by a mixture of a definite compound with a variable excess of polymerized sulphide.

In a word, two actions developed by the effluvium take place parallelly, namely, a combination of hydrogen or of nitrogen or of argon, and a polymerization, perhaps with separation of the sulphur of the carbon sulphide.

Nothing proves that the second phenomenon is negligible or even connected with the combination, any more than the formation of ozone is with the formation of nitrous vapor under the influence of the effluvium, at the expense of a mixture of nitrogen and oxygen, such as the atmospheric air. Without doubt, the last two reactions are simultaneous with strong electric tensions; but the ozone is formed only by weaker tensions. This observation, which I made formerly,* has been lately utilized in industry for producing ozone exempt from nitric compounds.—Annales de Chimie et de Physique.

REPORT OF BUREAU OF STEAM ENGINEERING ON LIQUID FUEL FOR NAVAL PURPOSES.

THE use of crude oil as a combustible for marine purposes has probably increased to a greater extent during the past two years than during the previous century. This has been due to several causes. The character of the oil lately discovered throughout the world is particularly applicable for use as a fuel. The oil fields are likewise near tide water, and therefore it is possible to construct pipe lines to the sea and deliver the product on board the tank steamers at comparatively slight cost. There is also good reason for believing that the wells are not likely to be soon exhausted and that an ample supply can be assured for an increased demand of the future.

It is evident that there is a very strong desire and purpose upon the part of many shipowners to substitute oil for coal. The thermal, mechanical, and commercial advantages that would result from a change are so well known that it is unnecessary to recount them. Nearly every reason that can be advanced for using oil as a fuel in the mercantile marine is also applicable to the Navy. In the case of warships, however, there are also military benefits to be secured that are as important as the commercial and mechanical advantages.

Any fuel installation that will obviate the smoke nuisance, reduce the complement in the fire room, extend the steaming radius of the war vessels, and permit maximum speed to be obtained at shorter notice, increases the efficiency and value of the fighting ship.

The numerous experiments that have been made by several naval powers during the past forty years in the attempt to use oil as a fuel show how important this question is regarded by military experts. It is now plain why success was not attained. There was too much effort exerted to burn oil in the same manner as coal. It is now realized that the oil should be atomized (it is impossible to completely gasify it) before ignition, and that the length of the furnace, the volume of the combustion chamber, and the calorimetric area are factors which must be considered. In fact, it is highly probable that it may be found advisable to design a special boiler for burning oil.

As more time, talent, and money are now being devoted to the solution of the problem, the hope of securing success has been greatly strengthened. Many unreliable statements have been published as to the success secured, but careful investigation shows that they were inspired by interested parties. It can be well understood that it is exceedingly difficult to secure reliable data at the present time. The several shipowners, manufacturers, and inventors are not inclined to tell of their disappointments, reverses, or failures. Those who have attained success as a result of experiment and experience do not feel called upon to give the world information that has been obtained at considerable cost and trouble.

Expert testimony is often of doubtful value. With regard to such testimony, a distinguished jurist once remarked that its character frequently depended upon who paid the retaining and professional fee. In view, therefore, of the trifling amount of reliable data extant, the Bureau has projected an extended series of tests to determine the value of liquid fuel for naval purposes. These experiments commenced a few months ago. Taking into consideration the inevitable delay that must result from the installation of various burners, and recognizing the fact that competitors expect and should be permitted to make preliminary trials, it can be stated that the experiments have been conducted with considerable rapidity. It takes about one week to install a new burner, make preliminary tests, and conduct two official trials.

In some quarters there seems to be a prevailing idea that the Government has established an experimental plant where inventors can have the opportunity of developing and perfecting their appliances. The Bureau has no such purpose, for it is expected that each competitor will carefully study the detailed drawings furnished him of the experimental plant, and therefore be prepared to fit his appliance and be ready for a preliminary trial in two days from the time the plant is placed at his disposal.

The problem of using liquid fuel for naval purposes is quite distinct from the problem of its use in the mercantile marine, although the conditions on passenger and freight ships approximate very closely in some respects to service requirements. For ships of war the problem can therefore be solved only by the Department making its own tests and experiments. The performances, however, of the merchant ships having oil-fuel installations have been carefully observed. Representatives of the Bureau have been officially directed to report and observe upon the efficiency and sufficiency of such installations. Some of the most successful marine installations on both the Atlantic and Pacific coasts have been examined. The owners of the steamers "J. M. Guffey," "Paraguay," "City of Everett," and "Mariposa," having permitted the Bureau to report upon the oil-fuel installations of those vessels, a careful and extended investigation as to the character of each of their plants has been made. The liquid-fuel board has also examined the method of refining oil, and the Department has communicated with scores of individuals and corporations who have demonstrated by actual experience that their appliances possess merit.

The more this question is investigated the more in-

* Essai de Mécanique Chimique, II, p. 375.