

alpha rays produce lively movement of the electrometer string. By interposing a sheet of paper the alpha rays are cut off, but the beta rays continue to affect the instrument, and the number of beta particles thus detected is quite large, for the particles come from the interior, as well as from the surface, of the pitch-

blend. Even the presence of gamma rays can be detected by interposing a sheet of lead one twelfth inch thick. The deflections then observed are caused by secondary beta rays generated by the gamma rays. The deflection and dispersion of beta rays can be demonstrated by similar simple experiments. In general, the

apparatus appears to furnish a simple means of studying the behavior of alpha and beta rays in various conditions. Experiments in this field have been undertaken in the Physikalisch-Technische Reichsanstalt, where the preliminary experiments described above were made.

The Manufacture and Uses of Blaugas*

Compressed and Liquefied Oilgas for Transportation in Cylinders

By Dr. Hugo Lieber

WILLIAM MURDOCH'S invention, in 1792, of a process for the manufacture of an illuminating gas, and the first establishment of a commercial gas plant in Birmingham, ten years later, was destined to be rapidly developed and perfected, so that it soon became a commercial necessity. However, one of the disadvantages of this invention was the fact that it required a considerable investment of capital for the manufacturing plant and its maintenance, and especially for the equipment of gas mains required to conduct the gas to the consumer. Therefore, it was soon recognized that a gas factory could be commercially and successfully operated only in such districts which were thickly populated, and where a large number of customers could be connected with the gas mains and thus be made consumers of this commodity.

The great advantages derived from the use of gas were soon recognized, and created a considerable demand for it, but owing to the limitations of a supply of gas to the territory traversed by the gas mains, and as beyond reach of these there was soon created a great and constantly growing demand for this commodity, many attempts were made to fill this demand.

These experiments resulted in various inventions of more or less value, having for their object the production of a compressed or condensed gas in such form that it would be commercially transportable beyond the reach of the gas mains.

In the experiments conducted by various investigators, coal gas as well as oil gas was used, but attempts to produce a commercially condensed and transportable coal gas were soon abandoned in favor of oil gas on account of the higher calorific value of the latter. The compressed oil gas is to-day still used very extensively, especially for lighting of railroads, buoys, light-houses, etc.

The compressing and commercially adopting of such compressed oil gas was successfully done especially by Pintsch, and with such compressed oil gas is usually identified the name of Pintsch owing to the great introduction of the Pintsch system throughout the world, and such compressed oil gas is usually known as Pintsch gas.

Under the Pintsch system, the oil is distilled at fairly high temperatures (900 deg. to 1,000 deg. Cent.) so as to produce as large an amount of fixed gases as possible. These fixed gases are subjected to a pressure ranging from 5 to 16 atmospheres, in the United States 6 atmospheres being the prevailing pressure. As under the Pintsch system, after distillation and compression, certain of the hydro-carbons are liquefied, these have to be removed, and only the remaining gaseous compressed hydro-carbons are permitted to enter the shipping containers.

A German chemist, Herman Blau, succeeded in making a great improvement in the production of a transportable compressed oil gas. He compressed oil gas to such a degree that the bulk of it was liquefied. The process employed by Blau is, in brief, as follows:

In the original process, gas oil is conducted into the retorts just as in the manufacture of Pintsch or other oil gas, and is vaporized and decomposed in these retorts under a temperature of about 550 deg. Cent. to 600 deg. Cent. This low temperature is employed in order to prevent the production of a large percentage of fixed gases, as contrary to the heretofore existing principle it was the desire of Blau to produce as large a quantity of the coercible hydro-carbons and as small a quantity of the permanent gases as possible. After the oil has thus been distilled, the gas obtained is conducted in the usual manner through hydraulic mains, coolers, cleaners and scrubbers in order to remove the tar which these gases contain. After this, the gas is purified of its chemical impurities by being forced through chemical cleansing agents, where especially sulphide of hydrogen and carbon dioxide, etc., are removed. This being completed, the gas is conducted in the usual manner into large gas holders for storage purposes. With the exception of the difference in the temperatures employed in the distillation process, the Blau process up to this point does not vary materially from any of the other well-known processes of oil gas distillation employed heretofore.

Since its first introduction, the Blau process has been

* Reproduced from *Metallurgical and Chemical Engineering*.

very materially and rapidly improved from time to time, these improvements having for their object the production of a better quality or a drier gas, and also the greater yield from a certain quantity of oil. In the original process as employed by Blau, the gas from the holder was drawn into a cooler where, under a suitable process, it was cooled considerably below zero in order to liquefy and discard at this stage certain of the coercible hydro-carbons which, in the finished product, were not desired; that is, such hydro-carbons which under normal pressure and temperature would again liquefy.

Under the new process, as it is employed in the various Blaugas factories at the present time, this preliminary cooling has been discarded. The gas is drawn directly from the holder into the compressor, which is usually a three-stage or four-stage compressor. The liquefying and discarding of those coercible hydro-carbons which are not desired in the final product now takes place in the first and second stage of the compressor, and the balance of the gas passes on into the third and eventually the fourth stage, where the gas is compressed up to 100 atmospheres. During all stages of the compression, water is injected into the compressing chambers for lubricating and cooling purposes. The water which is carried over after the final compression is separated from the liquefied hydro-carbons after the last stage of compression, and is then withdrawn from these by a suitable device. The refuse tar obtained from the cooled and scrubbed gases is collected in proper receptacles, and from there is pumped into tanks from where it flows by its own gravity to the retorts where, with compressed air or steam, it is sprayed under the retorts, and is thus used to supply all the heat required for these retorts.

As in the course of the manufacture, and during the distillation of the oil, a certain amount of permanent gases have been produced which the liquefied hydro-carbons have been unable to absorb, these permanent gases are conducted into large cylinders from which, by means of proper reducing and regulating valves, they are conducted into the engine, where they produce all the power which is needed in a Blaugas plant.

The whole Blaugas process, as it is now employed, is so minutely worked out that but a very slight excess of tar and permanent gases is obtained beyond the quantities required for heating and power purposes. The final product consisting of liquefied hydro-carbons, and absorbed therein or dissolved thereby non-liquefied hydro-carbons, is of such composition that this whole aggregate remains a liquid as long as it is under the pressure employed in the process, but these liquefied hydro-carbons at once become converted into a gaseous aggregate if the pressure is reduced to approximately atmospheric pressure. These liquefied hydro-carbons are conducted into suitable steel cylinders or bottles for transportation purposes.

Under the compression of 100 atmospheres, the oil gas is reduced to 1/400 of its volume, the gas so obtained being of a specific gravity which is approximately the same as that of atmospheric air. One liter, that is, 1.246 grammes of Blaugas at 0 deg. Cent. and 760 millimeters barometer contains 1.042 grammes carbon and 0.204 gramme hydrogen. This gas has a calorific value of about 1,800 B.t.u. per cubic foot, or approximately three times the heat value of ordinary city gas.

The explosive range of Blaugas is lower than that of any other commercial illuminating gas, which the following table will show:

	From	To	Explosive Range
Coal Gas.....	6.33% gas 93.67% air	19.33% gas 80.67% air	13.0%
Acetylene.....	2.00% gas 98.00% air	49.00% gas 51.00% air	47.0%
Hydrogen.....	9.50% gas 90.50% air	66.30% gas 33.70% air	56.8%
Blaugas.....	4.00% gas 96.00% air	8.00% gas 92.00% air	4.0%

As has been stated before, the heat value per cubic foot of Blaugas is about 1,800 B.t.u., whereas that of acetylene is 1,500 B.t.u. per cubic foot and of hydrogen 425 B.t.u. per cubic foot. As the volume of Blaugas is reduced to 1/400 under its compression, it requires much

smaller receptacles to transport a certain number of heat units with Blaugas than with any other gas.

Of the commercially transportable gases are to be considered acetylene, hydrogen and Blaugas, as Pintsch gas is a transportable gas in a limited sense only. Acetylene can be considered as a transportable gas only under the so-called "Acetylene Dissous" system. The following table will show the heat value per cubic foot, the container capacity, the weight of containers required for a given number of heat units, the number of containers required and the price per 100,000 B.t.u.:

	Hydrogen	Acetylene Dissous	Blaugas
Heat value, per cu. ft.	425 B.t.u.	1,500 B.t.u.	1,800 B.t.u.
Contents of a container of 1 cu. ft. water capacity....	120 cu. ft.	100 cu. ft.	300 cu. ft.
Weight of containers required to transport a given quantity of heat units (for example 540,000 B.t.u.)....	1,060 lbs.	432 lbs.	100 lbs.
Number of containers required to ship 5,400,000 B.t.u.	106	36	10
Price for 100,000 B.t.u.	\$1.41	\$1.00	\$0.44

Hydrogen, per cu. ft., 3/5 cent.
Acetylene Dissous, per cu. ft., 1 1/2 cents.
Blaugas, per cu. ft., 4/5 cent.

Blaugas is transported in steel cylinders of various dimensions ranging in size (water capacity contents) of from 1/4 liter to about 100 liters. The size mostly used is a cylinder with a water capacity of about 27 liters, or about 1 cubic foot. This cylinder when properly filled contains about 20 pounds of Blaugas, which will become converted into about 250 cubic feet of expanded gas when the pressure is released. As Blaugas contains no carbon monoxide, it is a non-poisonous gas.

Blaugas is used mostly in such districts where no gas is supplied from a central gas plant through ordinary mains, but it is also used very extensively in districts where city gas is supplied, especially for steel and cast-iron welding and cutting, brazing, soldering, for laboratories and such purposes where a uniform gas with high heat units is essential.

In districts where gas is not supplied through mains or through a central plant, Blaugas is used for all purposes where otherwise city gas is used, namely, for illuminating, cooking, ironing, heating, and similar purposes.

The cylinders are attached by means of a reducing valve to a small expansion tank, and from there the gas is conducted into the pipe line by a pressure regulator. As Blaugas is under a high pressure when delivered to the consumer, it is a very simple matter to produce so-called pressure gas wherever it is required, pressure gas being very desirable for the production of brilliant illumination, one c.b.f. of Blaugas producing 80 candles in an incandescent Welsbach burner.

The first Blaugas factory was erected in Augsburg, Germany. This was rapidly followed by other factories in Budapest, Copenhagen, Bucharest, St. Petersburg, and Hoek von Holland. In the United States, at the present time, there are factories in Long Island City, St. Paul, Kansas City, Omaha, and Portland, Me. There are a number of factories now in course of construction.

The Invention of Celluloid*

By L. H. Baekeland, Ph.D.

NEVER has the Perkin Medal been better awarded than to John Wesley Hyatt. He created a distinctly American industry, chemical in its very essence, although the inventor never claimed to be a chemist. He not only invented the fundamental principle on which this important industry is based, but he gave his fertile inventive genius and the better part of his life to the development of the many details which built up the technique of celluloid.

The technique of celluloid is strikingly different from that of rubber and all other plastics. This explains why rubber technologists ordinarily fail when they attempt celluloid manufacturing. It provides an excuse why the hard rubber companies of this country failed to see the coming importance of celluloid when the new material was offered to them.

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I believe it was Rudyard Kipling who, in one of his writings, refers to a fisherman who was specially successful because "he could think as a cod-fish would think." I have observed in meeting celluloid or rubber manufacturers that the former cannot think but "celluloid," and the latter "rubber," and are much at sea when they are confronted with the technique of a new plastic.

I may mention here, from conversations with the inventor himself, that celluloid and the celluloid industry with all that it implies, after all meant merely a big parenthesis in the life of Hyatt in his quest of a perfect billiard ball which would replace the expensive ivory article. This is so true that even during his later years, when he is well in the seventies, he has spent considerable time in the study of other plastics in his effort to still further perfect billiard balls. Celluloid and the celluloid industry are by no means the only inventions which Hyatt has to his credit; the famous Hyatt Roller Bearing which has developed into a large and successful manufacturing enterprise, his methods of water purification (with Isaiah S. Hyatt), his process for crushing sugar cane and his many other patents testify to the abundance as well as the diversity of his inventive achievements.

The invention of celluloid is an excellent example of how sometimes it is a real advantage for a man of genius not "to know too much"; not to be hampered by too much book knowledge if the latter tends to petrify the mind into a too one-sided point of view. In all his work Hyatt's keen observing mind was his sole guide. He tried things for himself. He did not rely overmuch on what others told him to be the facts, or on what was written in books. He wanted to be his own "authority." He found by experience that there are many things printed in books and chemical treatises "that ain't so."

He thus discovered the important fact, on which the whole celluloid industry is based, that a mixture of nitrocellulose, camphor and a small amount of alcohol, when properly prepared, becomes thermoplastic. In other words, it becomes soft when treated, can be molded in a hydraulic press, and after cooling to ordinary atmospheric pressure, it becomes again hard and strong.

His predecessors all used nitrocellulose in presence of relatively large amounts of solvents, and used a solution, or a relatively soft mass, from which the solvents were left to evaporate. This not only meant a considerable loss of solvents, but restricted enormously many possible technical applications. The mass shrunk in the act of drying and rapid molding was impractical, if not totally impossible.

Some of his predecessors had even used camphor in their solutions, although Hyatt knew nothing about this until it came out later in his patent suits. But his predecessors had used camphor merely as any other solvent. They had failed to observe or to grasp the great technical importance of the fact that camphor could make a solid solution with nitrocellulose and produce a thermoplastic mass.

This seemingly simple observation might have left very little imprint on any other but the actively constructive mind of a Hyatt. He saw right away that from that moment on he could employ purely mechanical means for molding rapidly and effectively and develop the technique of nitrocellulose plastics for purposes never dreamed of before. The principle was simple and the available methods seemed simple enough. But, as usual, when one tries a process commercially it was found that there were endless details which conspired to render the industrial and commercial development a far more difficult problem than the mere discovery of the new principle in the laboratory. Here the whole problem might have suffered shipwreck in the hands of any other man than Hyatt. The whole technique of celluloid was then developed painstakingly by him in all its endless details. Special machinery was invented, new methods were conceived. All this is shown by the numerous subsequent patents.

It is an axiom that the test of a valuable invention is that it should be infringed or attacked by those whose thinking cells are passive until some inventor arouses them out of their mental drowsiness.

Hyatt, in his patent suits, had plenty of experience of the kind. Fortunately, his financial backers could afford to defend his rights in the absurdly long and expensive patent litigation, which is a proverbial characteristic of the inefficient administration of the patent laws of this country.

I believe it was George Westinghouse who reminded us that every successful invention passes through three stages: The *first*, when it is said: "Such a thing is absurd or impossible." The *second* stage, after the patent descriptions have become public and have given others the means to imitate and try to find loopholes in the patent claims, begins when it is said: "The thing is not new." And *finally*, after the usefulness of the invention has become so obvious and the details connected therewith have penetrated through the hard skulls of the laggards, then it sounds: "There is no invention at all."

Hyatt's invention went through every one of these

three stages, and were it not for the Perkin Medal many of us might have forgotten that there ever was such a man as Hyatt and that there was a time when celluloid did not exist, or involved very difficult problems.

His patents were assailed on the ground that others before him had used solvents and camphor in conjunction with nitrocellulose, but it was studiously omitted that his predecessors had used these ingredients under entirely different conditions for entirely different purposes, and could not produce in that way Hyatt's valuable technical effect. The very solvents which proved a bar to any important applications for molded plastics Hyatt did away with when he conceived his thermoplastic mass.

Some of the early drawbacks in the technical applications of Hyatt's discovery were none other than chemical experts with which his financial backers surrounded him. Hyatt knew no chemistry, but he knew well-observed facts intimately connected with the details of the work he had undertaken. His knowledge of nitrocellulose was obtained piecemeal by his own experimenting. Facts found in books he accepted only after he had verified them. It so happened that he frequently noticed that printed statements did not agree with his own observations. One of the chemical experts insisted that "cellulose was cellulose," regardless of the source of supply, provided it was sufficiently purified, and that nitrocellulose made from any kind of pure cellulose had the same properties. Hyatt knew better when he found that the article made from ramie, the strongest and most expensive cellulose, was incomparably superior to that obtained from cheap cotton or cheap pulp cellulose.

Some chemical experts also made the positive statement to his backers that his process would surely lead to terrific explosion because he was heating in a hot press nothing less than gun cotton, which was known to be a violent explosive. Though Hyatt state that he had been using his process for quite a time and still was alive, it was objected that this was simply due to sheer good luck which would cease at some time; if ever it happened that by accident or carelessness the heat in his presses rose a little higher, a violent explosion was bound to occur, and this would be the end of the celluloid industry. These arguments were not by any means without logic. At that time it is doubtful whether any chemist who knew the chemical properties of nitrocellulose would not have thought it the height of folly to heat this substance under pressure.

Hyatt not being a chemist, preferred to try and see for himself what would occur. He took a good-sized block of celluloid and heated it in the hydraulic press at a temperature far superior to the relatively low temperatures he was using in practice. He tells me that he was sufficiently impressed by all the threatening talk of the chemical experts to screen himself from the press by means of several thicknesses of cross boards behind which he could peep on and see what was going to occur. After the temperature rose to the point when the celluloid began to be destroyed, the block started sizzling on account of the emission of gaseous products. But he continued the experiment until he made sure that nothing worse occurred than to spoil the material.

Automatic Stabilizers*

It is undeniable that pilots are opposed to the use of automatic stabilizers on aeroplanes, and as they do not usually give any reasons for their opposition, the inventors have good cause for accusing them of hindering progress. And yet the pilots are not far wrong. If they do act thus from prudence nobody will blame them, for although experiments with a badly designed stabilizer may enlighten the inventor as to the defects of his device, they will possibly be carried out at the expense of the aviator's safety.

But there is another cause other than justified cautiousness for the attitude of the pilots. All the stabilizers which I have seen up to the present have been founded on two hypotheses. Firstly, that the conditions for stability of an aeroplane, its position in the air, its speed, etc., are invariable during flight. Secondly, that the maneuvers to be carried out to bring the machine back to its stable equilibrium depend solely and directly on the disturbance which occurred during the flight.

But that is not even all. The conditions for stability of an aeroplane vary every instant with the atmospheric conditions. Having its symmetrical plane vertical, its flight path horizontal, and a constant speed, constitute the stable state of an aeroplane for certain atmospheric conditions only, i. e., absence of wind or the existence of an absolute constant wind in the region where the aeroplane flies. But these atmospheric conditions are absolutely exceptional, and to each variation of these conditions corresponds a variation of the stable equilibrium. Sometimes it is best to bank to the right, sometimes, on the other hand, it is advisable to bank to the left. Sometimes the pilot must fly *cabré* and sometimes he must fly

* Translation of an article by *Flight* from Bulletin mensuel de l' A. G. Ar. The author is Captain Bellenger, a well-known French army officer.

piqué, or again it may be advisable to increase the speed or to diminish it, and he constantly has to combine all these maneuvers. In other words, there does not exist a fixed stable equilibrium, but there is one corresponding to each particular atmospheric condition. The making of a pilot consists precisely in developing in him that sense of the air which will, at any instant, make him instinctively choose the best attitude. Up to the present it does not seem that this attitude can be determined.

A lengthy experience has taught me that the proper maneuver to execute in order to right a machine does not depend directly on the disturbance itself, but more on the cause of the disturbance, so that for two precisely identical attitudes taken by the same machine through different causes, the maneuver required to right the machine differs also. The word "remous," which has often been abused for the purpose of masking our ignorance of the matter itself, serves to denote every variation in the movement of the atmosphere, but these variations may be caused either by obstacles on the ground, by local calorific phenomena, by the electric state of certain regions of the air, or by other causes which the future may reveal, and the required maneuver varies in each case. How can the inert matter which constitutes the automatic stabilizer discern the difference in causes of the identical phenomena? And it is very often a question of life or death. Only a thinking and intelligent being—one acts more often from intuition than from reflection—can discern the difference and consequently modify the action. A thinking, feeling, acting organ—what is it but man?

Besides, it should be noted that an automatic stabilizer, since it is unable to perceive the cause of the disturbance, and is also unable to foresee or anticipate it, does not begin to work until after the disturbance in the path of the aeroplane has existed for some time. It should begin working beforehand in order to diminish the anticipated effect of the cause, and furnish the maximum of correction before the disturbance has reached its maximum. When a boat approaches a wave, does the pilot wait till his craft is careened by the wave before applying his maximum control? No; he measures with his eye the advancing wave, gives his boat the most favorable position, and does almost all his controlling before reaching the top of the wave, that is to say, at the moment when the *denivellation*—the variation in water level—attains its maximum. The same should be done in the air. But, because the air wave is not visible to the eye, our theorists do not see it, and, having never felt it, they deny the pilot, who does feel it, the right to know better than they themselves what is the matter. They consequently impose upon him the use of instruments which, provided they do not work wrongly, certainly have little effect. The result hereof has, moreover, been proved experimentally. Recently at Juvisy a machine fitted with an automatic stabilizer was flying simultaneously with other machines not so equipped, and all the eye-witnesses can testify that, although the machine fitted with the stabilizer did not require any control by the pilot, it was tossed about much more than were the other machines. How would it have fared in a gale?

If it is advisable to give the aeroplane such a form that it flies normally in a position which is comfortable for the pilot—with the head upward most of the time—it is indispensable to leave all the control organs at the disposal of the pilot exclusively.

Finally, the start, and especially the landing, involve very delicate maneuvers when the conditions for the equilibrium of the machine, as it changes its means of support, alter radically and rapidly. These maneuvers demand a certain judgment; it is a matter of importance, it will be agreed, whether the flight path becomes parallel to the ground at 10 centimeters or at 10 meters, or that the path of flight meets the ground before becoming parallel to it; and it will also be agreed that the most favorable moment for flattening out is of very short duration in aeroplanes traveling at a speed of 20, 30 or 50 meters per second. Also, and precisely on account of the lack of sentience, the automatic stabilizers must be disconnected when in the vicinity of the ground.

Also when the machine is far from the ground, and when its attitude is of more consequence for the comfort than for the safety of the pilot—perhaps even for Pégoud, although he finds it very comfortable to fly head down—the most tangible effect of the automatic stabilizer is to increase the fatigue of the pilot and the machine by enlarging the disturbances. When close to the ground—that is to say, when the attitude of the machine is of vital importance—the stabilizer must be disconnected.

Why then be bothered with such impediments? The management of an aeroplane is not a purely mechanical problem, the fixed principles of which allow of attributing an invariable and automatic solution; it is an ever-changing struggle with a very capricious and changeable element—the air; and to follow such an opponent in his feints and tricks requires more than raw material, it requires an organ with alert intelligence, supple and quick, with instantaneous decision—it requires a pilot.