

with once coaling. We do not possess a man-of-war of which this can be said, because we have no engines afloat so economical, no ship with so small a resistance. Too much importance cannot be paid, we think, to giving men-of-war such shapes as will secure the best possible coefficients; but unfortunately few ironclads are designed for speed, although it is the highest quality such ships can possess, giving them, as it does, the key of any position in which they may be placed, and enabling them to adopt just that style of fighting which suits them best. The high economy of the engines appears to be due in great part to the fact that the boilers are large enough to supply plenty of steam without unduly urging the fires. She has 19,400 ft. of heating surface, or 4.3 square feet per horse power at 15 knots—an unusually large proportion. The grate surface is not given in Mr. Samuda's paper; but, assuming it to be one twenty-fifth of the heating surface—a very common proportion—we have a total of 776 square feet; and for a total consumption of 6,300 lb. per hour this gives a consumption per square foot of grate per hour of only 8 lb. Under these conditions it is probable that the boilers evaporated not less than 11 lb. of water per pound of coal, so that the steam used per horse power per hour was 15.18 lb.—a possible but extremely low consumption.

We cannot take leave of the *Riachuelo* without commending her to the attention of the United States Government, and we would ask the Naval Advisory Board, or its ex-members to compare her with the *Chicago*. This vessel we have fully criticised already, and described and illustrated. It will therefore suffice to say here that the American-cruiser is to have a displacement of 4,500 tons, or only 1,200 tons less than that of the *Riachuelo*; and in not a single feature does she compare favorably with the latter. The *Chicago* is to be propelled by twin screws, and she is allowed 18,518 square feet of heating surface, 6,000 square feet of super-heating surface, and 800 square feet of grate—nominally more boiler power than that of the Brazilian ironclad. Yet she is expected to develop only 4,800 horse power, and have a maximum speed of but fifteen and a quarter knots while her bottom, which is not to be coppered like that of the *Riachuelo*, is clean. Her bunkers will stow 800 tons, the same quantity the *Riachuelo* carries, but she will only be able to keep the sea for six and a half days, and to steam but 1,950 miles. She could not cross the Atlantic. Her armor and her armament cannot bear comparison with those of the *Riachuelo*; while it is more than probable that she will cost at least as much. The two vessels supply an admirable illustration of the arguments which we have advanced—namely, that to design a good ironclad requires some experience; that no one in the United States possesses this essential; and that much better results could be got by copying the best English practice than can be had from original American design. It is to be hoped that peace may reign between the United States and Brazil; if not, the *Riachuelo* alone could destroy every ship of war the United States possesses, fighting them half a dozen at a time. The doings of the *Alabama* would be as nothing to her doings; and no Kearsarge exists in American waters that could destroy her. If the United States want war ships they cannot do better than buy a few in this country, if only to serve as patterns for use in their own navy yards. We do not know which has most cause to be proud of the *Riachuelo*—England or Brazil.—*The Engineer*.

CHEMICO-MECHANICAL PRINTING PROCESSES.

By HERMAN MEYER.

In recent times an actual revolution has taken place in the reproductive art. Among these are three processes which may be called autographic, chemigraphic, and phototypic, whereby lithographic plates as well as relief plates for type printing can be produced at much lower prices than before, while the copies are more accurate and the print cleaner.

The subject possesses sufficient general interest to induce us to translate the following description given by Meyer in the *Deutsche Industrie Zeitung* of Sept. 12, 1883:

THE AUTOGRAPHIC PROCESS.

In this process the drawing is made with greasy ink and transferred to stone or zinc by laying the drawing upon it face down and running both through a press. A smooth paper and a granular paper with a chalk surface are sold especially for this use. Drawings are made on the former with a pen and prepared ink, while autographic chalk is used on the latter, but it must not be washed. Both substances are greasy. It is all transferred to the zinc or stone, and then treated like an ordinary lithographic drawing.

The principle underlying the lithographic process is that when a roller covered with fatty ink is rolled over the plate, the ink only adheres to the lines of the drawings, for they alone are greasy. Then on covering the stone with a sheet of clean paper and running it between two rollers, the ink prints off on the paper.

The advantages of the autographic process are that it saves one drawing. A very accurate drawing has to be made for the lithographer to copy, and that costs nearly as much as the drawing on stone, and then it is often difficult to avoid some mistake or misunderstanding in the copy that the lithographer makes, as he does not understand the subject so well. Now the drawing can be made under supervision and the draughtsman can penetrate the object. He must, of course, work very accurately, for it is very difficult to make any changes and corrections, but this does not offer any more difficulty than in ordinary lithography, for single objects can be erased from the stone and then redrawn and printed on again.

The limitation to the use of chalk is the fineness of the grain. If not every draughtsman has full control of the material, still a dilettante who knows how to draw with chalk can make the drawing himself, and thus effect a considerable saving in expense. Pen-drawings are to be preferred for fine work, but for other work chalk is to be preferred, yet a combination of pen and chalk on grained paper does not give satisfactory results. In making the drawing the greatest neatness must be observed, for a slight imperceptible spot of grease or a drop of saliva will be reproduced in black.

ZINCOGRAPHY.

There is a great saving of money and time effected in preparing relief plates for letter-press printing, as wood engraving is a very tedious and costly process. The process known as zincography consists in making a relief of zinc instead of wood, so that when an inking roller is passed over it the raised portions take the ink so that it can be printed in a common press. A drawing is made as above described with a fatty ink, and then transferred to zinc instead of stone. Very fine asphalt dust is sprinkled over it, and adheres to the ink; then on warming the plate the asphalt melts and

runs, forming a protecting film, so that a slight relief is obtained by carefully etching it in dilute sulphuric acid. By rolling this with a fatty ink, dusting it with asphalt again, and repeating the etching, the relief is raised a little higher, and the process is repeated until the desired height is obtained.

The author says that plates prepared in this way in Vienna cost only 8 cents per square inch, a price astonishingly low compared with wood engraving. The limitations to this process are the same as for the lithographic. In many cases the method is perfectly satisfactory, and gives excellent results.

PHOTOTYPES.

For finer drawings, and especially for artistic work, a photo-relief process called a phototype is used. Although this costs twice as much per square inch, with \$1.00 or \$1.25 extra for the negative, it is still cheaper than wood engraving, and gives the most perfect results imaginable.

The original drawing is transferred to the zinc by photography, and forms the first protecting film. The etching is performed as in the previous process. The original drawing remains uninjured, and any drawing that does not consist of intermediate shade and tints, like India-ink pictures and photographs, but possesses a certain grain or is made in line, can be transferred in this way. In the same way engravings and wood-cuts can be reproduced very cheaply and with any desired reduction. A reduction of about two-thirds is generally advisable.

Although any suitable picture, such as crayon, chalk, pencil, or pen and ink sketch, engraving, or wood-cut can be reproduced in this way, still it is advisable, when a drawing is made expressly for this purpose, to make it large and shade it more heavily, as the shading looks fainter when it comes to be printed.

HOW TO WORK THE NEW COPYING PROCESS.

This process consists in transferring to a pad or tablet, composed essentially of a gelatinized solution of glue in glycerine, writings made on paper with a strong solution of one of the aniline dyes—violet or blue being generally preferred—and from this obtaining duplicate copies of the original by simply pressing sheets of paper on the transfer. The *modus operandi* of the copying is given briefly as follows:

Write with a steel pen on ordinary writing paper; allow to dry; press the writing gently upon the tablet; allow it to



NEW COPYING PAD.

remain a minute, when the greater part of the ink will have been transferred to the gelatinous surface, and as soon as the paper has been removed the tablet is ready to take impressions from. Place ordinary writing paper upon the charged tablet, smoothing over with the hand, and immediately remove the sheet, which will be found to bear a correct copy of the original writing; repeat with other sheets until the transferred ink becomes exhausted. Immediately after, wash the tablet with water and a sponge, let it dry, and it is ready again for use.

With a tablet and ink prepared according to the following, fifty good copies from one transfer have been obtained, and doubtless with care it would afford twice this number. The proportions for the pad or tablet are: Gelatine, 1 ounce. glycerine, 6 1/4 fluid ounces. Cooper's gelatine and pure concentrated glycerine answer very well. Soak the gelatine over night in cold water, and in the morning pour off the water and add the swelled gelatine to the glycerine heated to about 200° Fah. over a salt-water bath. Continue the heating for several hours to expel as much of the water as possible, then pour the clear solution into a shallow pan or on a piece of cardboard placed on a level table and having its edge turned up about 1/2 inch all around to retain the mixture, and let it remain for six hours or more, protected from dust. Rub over the surface a sponge slightly moistened with water, and let it nearly dry before making the first transfer. The ink is prepared by dissolving 1 ounce of aniline violet or blue (2 R B or 3 B) in 7 fluid ounces of hot water, and, on cooling, adding 1 ounce of wine spirit with 1/2 ounce of glycerine, a few drops of ether, and a drop of carbolic acid. Keep the ink in a well stoppered bottle.

NICKEL PLATING ON ZINC.

By Prof. H. MEIDINGER.

SUCCESSFUL electroplating in general depends upon three conditions: on the quality and properties of the metallic solution (the bath), on the strength of the current, and its relation to the surface of the pole, which determines the thickness of metal deposited in a unit of time (rapidity of precipitation), and on the nature of the surface of the pole on which the metal is to be deposited. If the pole is of metal and is to be inseparably united with the deposit, as is the case with silver plating, the surface must be perfectly clean and free from oxide or grease. If the surface is dirty, the precipitate peels off. It will not adhere at all to non-metallic substances, but merely incloses them.

It is a fact worthy of attention that under otherwise simi-

lar conditions many metals do not take certain deposits well. In some cases the deposit is streaked, powdered, or of bad color, and in others it peels off afterward when polished. Iron in its different forms (steel, wrought iron, or cast iron), zinc, lead, and tin cannot be readily silvered or gilded in the cyanide bath, although it works first rate on copper and its alloys, and is generally used for that purpose. But of the copper alloys German silver causes more difficulty than brass. Copper, brass, and iron are easily plated in the nickel bath; zinc, on the contrary, is not. In some of these cases the metal to be plated acts directly on the solution itself, as, for example, zinc acts on silver and nickel solutions, and this circumstance may effect the properties of the whole deposit; this does not happen with iron.

If a metal cannot be nicely plated in a bath, it is customary to cover it first with some other metal of better quality in this respect. Thus iron, zinc, and tin are easy to silver and gold plate after they have been copper plated, and zinc can also be nickel plated under these conditions.

To unite the deposit as firmly as possible with the object, it has been found in many cases advantageous to slightly amalgamate the surface of the metal to be plated, especially in giving a thick coating of silver to instruments. The method is extremely simple, for it is only necessary to dip the articles for a short time into a mercurial solution and then rinse them with water.

The quantity of mercury used is insignificant, in fact a heavy amalgamation must be avoided, as it would make the metal brittle. A mercurial solution serviceable for this purpose is made with the commercial mercuric nitrate or chloride (corrosive sublimate). The solution must be very dilute, about one, five, or at most ten parts of the dry salt in a thousand parts of water; to this solution some sulphuric or chlorhydric acid is to be added until the liquid is perfectly clear. The stronger solution gives up more mercury in a given time than a weaker one, and this must be taken into account in amalgamating. With practice it is easy to tell from the change of color when enough mercury has been deposited. Iron does not alloy, or only very badly, with mercury, and hence it cannot be subjected to the process just described.

Within the last decade nickel plating has reached an extraordinary development. At first it was limited to iron, then it was gradually extended to brass and German silver, and now is increasing in favor for coating zinc. As this metal takes the nickel from ordinary baths very badly, it has been proposed to copper-plate it in the cyanide bath. But this is a nuisance. The use of the poisonous cyanide bath should be avoided as far as possible, and limited to cases where it cannot be dispensed with; in nickel plating, cyanides are not absolutely necessary, even if an intermediate layer of copper is desirable in thick nickel plating. The cyanide of copper (and likewise brass) bath has a disagreeable property of only working when certain conditions are exactly observed; it also decomposes easily. As the nickel wears off by use the red shines through, which is worse than if the white zinc itself were laid bare. Experience also showed that coppered zinc, when it came into the nickel bath, at once turned black and could not be plated.

There is not yet any literature on amalgamating zinc for the purpose of nickeling it. On many sides objections are heard against the deficiencies of the customary process of nickel plating, and it seemed to me worth while to make some experiments in this direction. The experiments were satisfactory. I amalgamated a sheet of zinc, and then had it nickel plated by Schwerdt in Carlsruhe. The nickel adhered well, united perfectly, and took a fine polish. I think it is not improbable that the nickeled sheet-zinc of commerce is prepared in a similar manner. This supposition receives support from one of the properties of this zinc to which my attention was called by Beuttenmüller, who has used a good deal of it in his factory.

It is rather brittle in comparison with pure sheet zinc. I cannot explain this brittleness in any other way than due to amalgamation. The alloys of mercury with solid metals, called amalgams, exhibit this property—that the mercury dissolves off small quantities of the metals to form a thicker liquid; with a larger excess of the solid metals the alloys are solid, but fragile and brittle. This character remains, but grows gradually less. When a sheet of metal is amalgamated, it depends on the quantity of mercury combined with it and the depth to which it penetrates, whether it will cause a perceptible change in the strength of the metal.

Copper must remain in contact with mercury for a long time until it has penetrated a considerable depth; with zinc this takes place very rapidly. A sheet of zinc one millimeter in thickness, thoroughly cleansed in acids, only needs to have metallic mercury poured over it so that it forms a bright mirror to make it so brittle that it will not stand bending. Zinc carries this peculiarity into its alloys with copper, so that brass and German silver are much more sensitive to mercury than copper. If zinc is immersed in a mercurial solution, it will depend upon the time it stays in whether the mercury will be merely deposited upon the surface or will penetrate more deeply into the zinc. A concentrated mercurial solution will make a sheet of zinc one millimeter thick brittle in a few minutes.

The quantity of metal necessary for nickel plating will have an imperceptible influence on its strength if the zinc is thick; but if it is thin it may show a perceptible difference, which makes it difficult to work the zinc. Special care must be taken to prevent too much mercury being deposited on the zinc by leaving it in the solution too long. The exact quantity can only be determined by experiments that are simple and easily carried out.

When one metal is deposited on another by the galvanic current, we cannot speak of them as alloys if they are inseparable, for they are only held together by adhesion. Hence there can be no change in the characters of the two metals; neither a harder nor a more brittle product results from electroplating. If the latter is observed, even in a slight degree, it is easy to conclude that there is mercury in it.

Pure zinc has a different action on nickel solutions from amalgamated zinc. The former soon turns yellow and brown, and the deposit can be rubbed off with a piece of paper. If a feeble current is employed this chemical action preponderates, and hence we obtain a poor deposit. If the current is very strong, the zinc will be more rapidly coated with nickel by electrical action than it would by the chemical action of zinc on the solution, and a good deposit can be obtained. It is only by observing these precautions that it is possible to nickel plate zinc directly, and yet this is frequently inconvenient. If amalgamated zinc is dipped into a nickel solution, after a long time feeble action will begin. The mercury, although there is so little of it, protects the zinc against the action of the liquid, as zinc in its alloys with copper, brass, etc., is protected against the attacks of different liquids, copper sulphate, sulphuric acid, etc. Yet in all these cases the protection is incomplete; after a while a

slight action is observed. In nickel plating zinc, slight amalgamation will suffice to secure a good deposit with a feeble current.

It has been observed that some kinds of German silver take nickel badly; previous amalgamation may, perhaps, be an advantage here too.—*Badische Gewerbe Zeitung*.

OLEUM GAULTHERIÆ—OIL OF WINTERGREEN.

By ISAAC EDWARD LEONARD, Ph.G.

OIL of wintergreen was first made in Luzerne County, Pa., in 1863, from which time it has been distilled in great quantities, with the exception of last year, when the yield was not so plentiful, owing to the destruction of the shrubberies by the fire which passed over our mountains.

In distilling, the entire overground portion of the plant is employed, which has its greatest yield during the months of July and August.

The still is generally a wooden box, about 8 feet long, 4 feet wide, 4 feet high, with a copper bottom and stayed with bolts. The head of the still is copper, and connecting with this is a square or circular worm of the same material or of tin, placed in a barrel. The still being filled with wintergreen to within about 12 inches of the top, a sufficient quantity of water is added, and this is allowed to macerate from ten to twelve hours. The fire being started, the distillation commences and continues for about eight hours; but during the first two or three hours, 90 per cent. of the oil has passed over. For collecting the distillate, most of the stillers use a wide mouth bottle or fruit jar, fitted with a large cork having two holes. A small tin or glass funnel is put into one of the holes, so that the beak of the funnel is below the shoulder of the receiving vessel, and connected with the other hole is a suitable pipe forming an egress. The distillate passes into the receiving vessel through the funnel. It is here that the oil and the water separate, the oil going to the bottom, and the water, being lighter and in excess, passes through the egress pipe into a larger receptacle, where it is reserved for a subsequent operation (cobobation).

Occasionally the oil is very highly colored. I have found several samples to contain traces of iron, which is due to the oxidation of the tin worm or can with which the oil comes in contact. Tin worms are used on account of their cheapness, but will only last about two weeks before they undergo oxidation.

The wholesale dealers that handle the oil in large quantities have three ways of "cleaning" it: redistillation, filtration, and decolorization. The first two processes are easily understood, while the decolorization seems a difficult one, but is much easier than either of the others. The oil to be decolorized is put into a bottle, and crystals of citric acid are added, the whole allowed to stand, agitating occasionally, until the oil is colorless, or nearly so.

On experimenting with nine quarts of wintergreen fruit, I found it contained one and one-half drachms of oil. The chief uses of the oil are for flavoring and in printing fine calicoes.

In experimental distillation, I found that the lower specific gravity is due to the separating of the oil from the water too quickly, and that the higher specific gravity is obtained by letting the distillate stand from twenty-four to forty-eight hours before separating the oil from the water.

THE GASES SUPPLIED TO NEW YORK THEIR MANUFACTURE AND COMPOSITION.

THE recent effort made to inspect the character and manufacture of water gas, accompanied with an associated design upon the other gas companies, may awake at least some intelligent desire in the public to know what are the sorts of gas at present furnished in the city, and the processes by which they are made.

About six months ago there were four processes employed by the seven companies which supply New York city with its light, and the resultant gas from each possessed its peculiar constitution, advantages, and disadvantages. One of these processes has, I believe, been abandoned, but the explanation of the four then used, will adequately suggest the divided sources whence we are supplied with gas.

First in order by reason of its antiquity, and the prominent defense made for it by the representative gaslight company of the city—the Manhattan—comes the coal gas, made by the distillation of bituminous and cannel coals. These rich and hydrogenous bodies when inclosed in hermetically sealed vessels—the clay retorts of the present gas houses—and exposed to high heats ranging from 1,200° to 1,500° Fah., yield large quantities of volatile materials, which ascend from them in a mixed state, and it is the design of the subsequent steps in gas making to separate this unsalable mixture into a number of component bodies, of which the gas is the last and most valuable. Or putting it more literally, it is the duty of a gas engineer to free the gas from the presence of all hurtful or useless bodies which are mingled with it upon its ascent from the retorts where it is generated.

The volatile bodies arising from such a charge of bituminous or cannel coal are very numerous, and vary according to the character of the coal employed and the degree of heat. It is unnecessary to enumerate them, but they form a great number in the aggregate, besides a large amount of tarry matter which is volatilized at the high heat, only to be carried a short distance, when, after cooling, it is deposited and forms the tar of gas houses, a residual of the deepest interest scientifically, and commercially quite valuable. This indefinite and varying mixture of vapors, gases, and volatile salts can be considered as composed first of the necessary elements of the commercial gas, secondly of the gases which, while unavoidably accompanying the finished gas, are unnecessary, viz., the diluents of the gas, and thirdly, the impurities which must be removed to render the gas pure, so that it can be easily and safely burned.

Let us step into a gas house, and notice some of the steps by which this is accomplished. We open the door of a long rectangular structure, along whose open roof pour mingled clouds of vapor and smoke. We enter, and meet an interesting scene. Down the center of the wide and lofty room extends a solid mass of brick masonry, in which the clay retorts, where the gas is first formed, are embedded. These clay retorts are A shaped, 10 feet long, and mounted upon supports of fire bricks, in sets of 5. Each set is exposed to the flames arising from a furnace beneath, which is either a simple coke furnace or a generator furnace of new and skillful construction, intended to supply the heat necessary for the distillation of the coal with greater uniformity and more cheaply.

Each retort is charged with about 200 lb. coal, which is inserted upon an iron, gutter-shaped scoop, and after four hours the retorts are opened, and the coke, left in the retort,

withdrawn. The perspective down the long face of retorts which are being charged and "drawn," with the mouths of some encircled by tongues of flame, while clouds of steam and wreaths of smoke ascend in cyclonic curves around the titanic forms of the bare-armed dusky, and sweating stokers, forms a picturesque and striking picture. Three of these strong men seize the iron scoop, two on the sides, and one at the handle, and lifting it up together rush forward toward the open mouthed retort; the end of the scoop is inserted, and by a dexterous and rotatory motion thrust to the end, overturned, and withdrawn. The retort is then quickly luted, or closed with its iron mouth piece, and the charge left. When the retort charge has given off all its gaseous contents the men approach, unlute the mouth piece, apply a lighted paper to the remnant of gas that issues into the air. It flashes into flame with a slight explosion, and pours upward a volume of smoke; the glowing heaps of coke are seen within the long retort, with the unsteady motion of the heated air rising over them.

This coke is withdrawn by a long hoe-like instrument, and it falls into cellars below, where it is cooled by water being thrown upon it, and carted away. From the retorts, the gas and mingled products pass into the hydraulic main, a long iron trough where the heavy condensable tarry particles drop out, forming a viscous, flowing body, which is the gas tar. The gas is still very hot, and loaded with condensable vapors, etc. To cool it, it is passed through a series of upright tubes of iron in contact with water, where it is cooled down to somewhere about 70°. The impurities are now to be removed, and they consist principally of ammonia salts, sulphur compounds, and carbonic acid.

Then it passes through an operation, very frequently divided into two steps, and also often combined into one, viz., washing and scrubbing. The scrubbing takes out fine particles of tar; this may be omitted, if the previous condensing has been very perfectly effected. It is usually accomplished by forcing the gas through a dense pile of birch brush or lattice work or coke piles. Water trickles down over these, and absorbs part of the ammonia salts. High towers with water sprays falling down them over woodwork or revolving disks of iron in water complete the removal of the ammonia. The gas freed from ammonia passes through boxes of wet lime, so disposed that the most impure gas meets the lime box most soiled. The gas parts here with its sulphur compounds and carbonic acid, then its volume is measured by enormous meters, it is passed into the great cylindrical holders which attract so much attention from the streets upon which they are placed, and is ready for delivery to the consumers.

The gas finished has about the following composition, it itself being a mixture of seven other gases, some of which are not always present:

ANALYSIS OF MANHATTAN CO.'S GAS BY DR. E. G. LOVE.

Hydrogen	45.79
Marsh gas	39.01
Carbonic oxide	6.31
Illuminants	6.38
Nitrogen	2.51
Carbonic acid	—
Oxygen	—
	100.00

The sulphur in gas should not exceed 20 grains per 100 cubic feet, the ammonia not 5 grains per 100 cubic feet, and there should be no carbonic acid nor sulphureted hydrogen. The former destroys the illuminating power, the latter is injurious. The candle power is taken constantly at the works, and affords a convenient index of the character of the gas. It is not necessary to enter now into an explanation of this test, but simply to say it consists in finding out how many standard candles the light of five feet of gas equals. This number is called the candle power, that vexatious and cabalistic utterance of gas men. In ordinary coal gas it varies from 16 to over 20.

Coal gas made in this manner is supplied to New York by two companies only, the Manhattan and Harlem.

A modified form of coal gas manufacture is in use at the works of the Metropolitan Gaslight Co. The light giving ingredients of this gas are added to it by petroleum naphtha, which is introduced into separate retorts by means of an iron tube, telescoped in a series of lengths of wider pipe, until at the further end from the mouth of the retort the oil escapes as vapor and returns the entire length of the retort to the mouth again, exposed to the high heat of the sides. This converts it more or less into a permanent gas, and it then passes on through a treatment similar to that employed with the coal gas. The coal gas made by this company is of an inferior quality, but is enriched by this oil gas and made a very excellent product.

The gas has the following composition as analyzed by the writer:

Hydrogen	38.50
Marsh gas	41.00
Carbonic oxide	8.50
Nitrogen	4.50
Oxygen	—
Carbonic acid	—
Illuminants	7.50
	100.00

It has a candle power of about 23 ranging under and above this.

The water gas which has been introduced within the last five years into quite extensive use in New York is itself no new discovery; the chemical laws involved in its formation were known 50 years ago, but the present process of enriching it with light-giving bodies is comparatively recent, and the method of its manufacture has been considerably modified.

The process employed in the city by the companies furnishing this style of gas is substantially as follows: Large iron furnaces lined with firebrick, and technically designated as *gasogens*, are filled with anthracite coal, which is fired, and by suitable air blasts brought up to a very high heat; into this glowing mass superheated steam is injected, which, encountering the white-hot coals, is shattered, as it were, into its components, hydrogen and oxygen; the oxygen combines instantly with the carbon of the coal, forming carbonic oxide and carbonic acid, and the hydrogen remains unchanged. This rapid decomposition of the steam absorbs an immense quantity of heat, and in ten minutes' time the steam is turned off, as the coal is cooled too much to permit further action; the air blasts again heats up the mass, and the steam blast succeeds it, and so with an intermittent action the gas is formed, which has almost no illuminating power. It may be added that marsh gas, oxygen, and nitrogen, and ammo-

nia and sulphur compounds accompany the gas to some extent.

This gas is enriched by passing over trays of naphtha in a hot water jacket, which saturate it with illuminants. But these would drop out or condense in the cold, and to fix them as gas, the mingled gas and vapor is passed through retorts kept at a certain heat which decomposes the naphtha vapor into marsh gas and light giving bodies.

After purification the gas is ready for use. Its characteristics are high illuminating power and a high percentage of the poisonous component, carbonic oxide. Its composition is as follows:

ANALYSIS BY DR. E. G. LOVE.

Hydrogen	26.25
Marsh gas	28.91
Carbonic oxide	27.12
Illuminants	15.80
Carbonic acid	—
Oxygen	—
Nitrogen	1.92
	100.00

The writer has experimented upon its poisonous qualities, and found some years ago, that with equal amounts of Metropolitan and Municipal gases in a cubic foot of air rats lived five times longer in the former than in the latter. Of course, as the percentage of either was greatly increased, the difference would be far less marked, and it would seem that ordinary precautions would never allow this poisonous ingredient to work much harm. From analyses made later than the above by the writer, the carbonic oxide appears to have been diminished. The candle power of the gas varies from 28 to 30, and sometimes falls below the former number.

This gas is furnished to New York by the Municipal, New York, and Knickerbocker Gas Light Companies.

The last process of making this indispensable article was used by one company only in New York, the Mutual, and has, I believe, been abandoned.

It consisted in distilling wood instead of coal in clay retorts. Virginia pine was used, and about 47,000 cubic feet of crude gas was obtained from one cord of wood. This is a very poor gas, and was enriched in a manner almost identical with that described for water gas.

Its composition when finished and ready for sale was:

ANALYSIS BY DR. E. G. LOVE.

Hydrogen	12.75
Marsh gas	39.21
Carbonic oxide	12.33
Illuminants	15.22
Nitrogen	19.86
Carbonic acid	0.89
Oxygen	0.24
	100.00

A water gas has since been substituted for the above by the Mutual Company of a candle power of 25 to 28.

The introduction of water gas and naphtha-enriched gases has increased the quality of the product, and necessitated high pressures, both to enable the consumer to burn enough and to render the combustion of the flame smokeless. The statement made recently to a reporter of the *Evening Post* that gas bills had increased on account of the greater lightness of the water gas is absurdly false, as the gravity of coal gases, taking air as unity, averages 0.430, while the gravity of enriched water gases ranges from 0.620 to 0.660. Larger burners and a more lavish use of gas on the part of consumers are the more likely causes of this unpleasant improvement in gas bills.

The districts supplied by the various companies are outlined as follows: The New York, below Grand Street to the Battery; the Mutual runs its pipes also in this region. The Manhattan, from Grand to 34th Street. This region is intersected by the mains of both Mutual and Municipal. The Metropolitan, from 34th to 79th Street. Through this territory the Municipal and Mutual companies supply their own consumers. Above 79th Street through Harlem, the Harlem Gas Company furnishes the most of the gas consumed, though they encounter the mains of the Knickerbocker at many points.

Some idea of the amount of capital put into mains may be formed from the tabulated statement of the lengths of gas pipe possessed by the several companies in the city:

Companies.	Miles of mains.
Manhattan	173
Harlem	118
Metropolitan	130
N. Y. Mutual	118
New York	110
Municipal	95
	L. P. G.

OXIDATION OF SULPHUR COMPOUNDS.

By DR. G. LUNGE.

IN presence of an excess of soda, sodium sulphide is transformed during concentration into hyposulphite, by the action of the atmospheric oxygen alone. If the lye at the moment of caustification is agitated by means of a current of air, the sulphide disappears entirely. But, subsequently, when the concentration has raised the boiling-point to about 140°, the hyposulphite splits up into sodium sulphide and sulphite. The former may be again oxidized by the same process, and the cycle of reactions be repeated, all the sulphide may be converted into sulphite; but this change, at temperatures below 360°, requires a very long time. Sodium sulphite is oxidized by the air to sulphate, the more rapidly the higher the temperature; at a red heat the introduction of a current of air converts all the sulphide into sulphate. Sodium sulphide may also be oxidized by means of niter. The reaction begins below 140°, and if the oxidizing agent is not in excess, which is always the case in practice, it is entirely changed into nitrite.

This body subsequently reacts upon the sulphide, not yet attacked, and converts it into sulphite. There the reciprocal action ends, the sulphite and nitrite remaining in presence of each other up to nearly 360°. At this temperature sulphate is formed with liberation of nitrogen. The action of nitrate never produces hyposulphite. That which is formed in the crude caustic lyes is produced at the expense of atmospheric oxygen. The hyposulphite is relatively very stable. The niter passes at first into the state of nitrate, which, in presence of oxidizable sulphur, is totally reduced with liberation of ammonia.

This reaction begins at about 140° in iron vessels. Along