lite in equal proportions and heats to fusion. Volatile silicon fluoride is said to be formed, while the aluminum is left as an alloy with the iron. On fusing this with copper an aluminum bronze is obtained and only a small amount of the aluminum is said to remain with the iron. It is an alloy of the metal and iron, made by the Cowles Electric Smelting Company, which is used in the Mitis casting process. Its average composition is aluminum, 7.5 per cent.; silicon, $1\frac{1}{2}$ per cent.; carbon, about 4 per cent.

Such, then, is the position of the aluminum industry at the present time. We have pointed out that the resistance of the metal to oxidation has not been proved, nor will the mechanical properties as evidenced by the latest researches tend to strengthen the high opinion of its value, which in many cases has, we think, been exaggerated. Thus a wire of No. 18 gauge gave a strain averaging 7.9 tons per square inch. This is extremely low. Cast and hammered aluminum gave 7 tons. By cold hammering 13.2 tons could be obtained. Again, the latest determination of the specific gravity of aluminum is 2.583, which is higher than that generally ascribed to it. The difficulty of working aluminum is very great, and until two or three years ago no means were known for even soldering it, either to itself or other metals. Comparing these results with those obtained from its alloys, it would seem, as we have said, that the future of aluminum lay not so much in the preparation of the pure metal as in the production of its much more controllable alloys, some of which promise to possess a high value as constructive materials.—*Engineering*.

HENDERSON'S STEEL PROCESSES.

WE published a description, on January 15, of Henderson's gas furnace, and we now publish a summary of the results attained by it. It was designed to effect the perfect combustion of fuel, which it does, owing to the means therein described for supplying the gases in the exact chemical proportions in which they are required, and brought together in such a manner that the different molecules may readily do so. As a blast furnace is a perfect gas producer, it used to make the gases (though on a greatly reduced scale). Non-coking coal containing $4\frac{1}{2}$ to 5 per cent. of hydrogen is charged with enough lime to scorchify the ash, and it is kept full of coal, and blast at $1\frac{1}{2}$ pounds pressure is forced into the hearth. This regulates the quantity of gas by burning the coke made in the upper part, which contains two retorts, into which the coal is charged. The heat of the producer causes the volatile matter in the coal to distill off, as they contain about eight hours' supply, and the coal is coked by the time it reaches the lower hearth. The flux insures a clean surface on the coke, free of ash. Thus by the gradual distillation of the coal, the clean surface of the coke, and the measured quantity of air, the quantity of gas is accurately known, and also its chemical composition. It then remains to mix them, as they pass through the outlet of the producer leading into the heating chamber, with a measured quantity of heated air applied under pressure in the flues so as to produce thorough admixture and complete combustion. This combustion thoroughly mixes all of the elements in the flame, and it becomes homogeneous, and its full chemical effect is exerted upon the articles to be heated from the time it enters until it leaves the apparatus.

Crude iron, mixed with 30 per cent. of steel scrap, exposed in this flame, becomes decarbonized and dephosphorized by the time it melts, if the carbon is about $1\frac{1}{2}$ per cent. and the phosphorus $3\frac{1}{2}$ per cent., and the steel contains 0.04 per cent. of phosphorus. Charging the furnace takes one hour for $12\frac{1}{2}$ tons, melting and pouring two hours, and repairs half an hour. The coal used is about 1,250 pounds per hour. Over one-half of the phosphorus volatilizes, and the remainder is absorbed by the lime worn away from the lining of the hearth. When the iron contains 3 per cent. of carbon less fuel is used, and the operation may be divided by using the iron molten from a blast furnace, by pouring it into the second melting chamber and refining it with iron ore and removing a part of the carbon, which is done by the waste heat of the first chamber. The metal is then run from the second chamber into the first chamber, where it is boiled and decarbonized into soft steel, in one hour, by use of brick of iron ore and fluorspar partially covering the hearth. While a charge is refining in the second hearth, the previous charge is being decarbonized and finished in the first hearth; and allowing half an hour for repairs, the operation occupies one and a half hours for converting crude iron into soft steel, so that sixteen operations may be made in twenty-four hours, or a furnace of $12\frac{1}{2}$ tons capacity be made to produce 200 tons of steel per day, from a plant costing \$15,000 exclusive of building, the consumption of coal being 150 pounds, which is but one-fourth of the coal used for the coke to melt a ton of pig iron in cupola. The arrangement for burning the carbon of the iron in the second chamber utilizes half as much fuel as the gas producer supplies. The use of iron ore adds about 5 per cent. of steel above the weight of the pig iron charged, so that the 7 per cent. of impurities in the pig iron is replaced by iron derived from the ore, or 12 per cent. of steel is derived from it, and by skillful manipulation of the furnace but very little oxide of iron remains in the slag. By heating the ingots with radiated heat, there is no waste by oxidation, and they may be rolled direct to the rail without loss, yielding twenty-one cut of rails and scrap from a ton of pig iron.

Phosphoric pig iron gives better results than Bessemer iron, as the flame removes the phosphorus to less than half that usual in Bessemer iron and steel. The phosphorus is almost all recovered as by-products, except that left in the steel. A part combines with the lime worn away from the hearth and becomes phosphate of lime, which is pulverized and used for manure by spreading it over land. The other part is volatilized and cooled and condensed in milk lime to become phosphate of lime when no fluorspar is used; but when fluorspar is used, fluoride of phosphorus is produced, and it is condensed in cold water, and the phosphorus is separated by draining away the hydrofluoric acid, which is made by the decomposition of the gas. Milk lime may be used instead of water, in which case the fluoride of phosphorus combines with the lime, and they become artificial apatite, which is a substitute for phosphate of lime for manure. Crude iron containing $3\frac{1}{2}$ per cent. of phosphorus yields

enough by-products to enable the steel ingot to be produced free of cost, as every 1 per cent. yields phosphate of lime worth \$4.15 net per ton. These processes also enable the use of crude iron containing sulphur, that would otherwise be unfit.

These inventions produce the perfect combustion and utilization of fuel, and enable the use of all kinds of iron ores and fuels for the production of steel with great economy, and the utilization of the hitherto deleterious elements in crude iron as valuable by-products, and a comparatively valueless reagent—fluorspar—becomes the source of supply of hydrofluoric acid at a merely nominal cost. This acid is a useful reagent in manufacturing, such as separating animal from vegetable fiber, treating alkaline chlorides to form potash and soda, and for producing artificial fluoride of calcium in the steel processes, and other uses.

REASONS WHY MERCURY MAY BE CONSIDERED A COMPOUND OF GOLD AND THALLIUM.

THE specific gravity numbers given are taken from the Encyclopædia Britannica, and the atomic weights from Wurtz's Atomic Theory.

	Specific Gravity.	Atomic Weight.
Gold (ingot).....	19.26	196.2
Thallium.....	11.86	203.6
Mercury.....	13.26	200.0

If the atomic weights of gold and thallium are added together, and divided by two, we get almost the exact atomic weight of mercury, the figures being 199.9. The fact may be referred to here that the theoretical vapor density of mercury has also to be divided by two to get the value obtained by experiment.

An alloy formed from equal weights of gold and thallium would have a specific gravity rather more than that of liquid mercury; but as there is known to be an expansion of volume with some gold alloys, the discrepancy in this case does not prove anything.

It will be noticed from the figures that there is exactly the same difference between the specific gravities of gold and thallium as there is between their atomic weights—7.4; the metal having the highest atomic weight possessing the lowest density, which would appear to show some connection between the two properties.

A similar relationship may perhaps exist between other pairs of elements, although the figures are not as close as in the case of gold and thallium; silver and palladium, copper and zinc, platinum and iridium, nickel and cobalt, are instances.

Of all the metals that are not rapidly oxidized in air, thallium is the softest, being scratched even by lead, and melting at 190° C. When in a liquid condition, it looks exactly like mercury, and like that metal is not attacked by hydrochloric acid. It is a very widely distributed substance, being found principally in combination with iron and copper sulphides, in pyrite associated with gold and other metals. By means of spectrum analysis, a very minute trace of the metal can be detected, as it gives a characteristic bright green band, which has been noticed in medicinal preparations of mercury which are presumably pure. The band visible in such cases may be due to a slight trace of free thallium, present as an impurity, but it may also possibly result from a slight decomposition of the mercury, and this may also occur in the animal system, which would account for the presence of gold in the body and excretions when, so far as known, it has not been swallowed.

According to medical works, the action of gold on the animal system more nearly resembles that of mercury than any other metal. This was also shown by some remarkable experiments recently tried in France, the mere proximity of some substances producing powerful effects upon certain individuals; the action of gold and mercury, and the chlorides of these metals, being especially strong and precisely similar. As well known, thin films of gold transmit light of a green color, but if largely alloyed with silver, the light is violet. The light passing through thin films of mercury is bluish purple; and as there is not much difference between this and violet, silver and thallium may be supposed to modify the transparency of gold in a similar manner. It is rather significant that, with the possible exception of copper, gold and mercury are, so far as known, the only metals through which light can pass, even the infinitely thin films of silver which can be produced by chemical action being absolutely opaque.

The liquid condition of mercury is a fact in support of the compound theory, because generally a combination of two or more metals is more easily brought to a liquid condition than the components would be separately, a mixture of sodium and potassium being, in fact, fluid at ordinary temperatures. The addition of lead lowers the melting point of platinum more than 1600° C., which would be more than sufficient to liquefy gold, the melting point of which is 1100° C., and is said to be reduced to about 400° by the least trace of silicon, and if heated with a large proportion of zinc, the two vaporize together. Lead also has a remarkable effect upon gold, the 1-2000 part making it extremely brittle, and altering its color. The readiness with which mercury is attacked by substances which have no effect upon gold, nitric acid for example, may be compared to the action of this acid upon platinum alloyed with silver. The great resistance offered by mercury to an electric current, its high specific gravity, its power to dissolve gold, and its greater affinity for that metal than for any other, are facts which also lend support to the theory advanced.

With regard to the differences which exist between the three metals, they are less than those which exist between some known compounds and their constituents—bisulphide of carbon, for instance, a colorless, very volatile liquid formed by the combination of two solids, one yellow, the other black. The properties of compound radicals may also be referred to as meeting a possible objection to the theory.

Assuming that mercury consists of the metals gold and thallium, it is probable that the latter did not exist in the free state until their separation from each other, that they were produced together in the form of mercury, perhaps from non-metallic substances. If this theory is correct, all the gold obtained has resulted from the decomposition of mercury, sometimes on the spot where the gold is found. This appears a reasonable supposition, from the fact that those States from which the most gold has been obtained are the richest in

various ores of quicksilver, and as far as this country is concerned, are the only ones where the ores exist in any quantity. A native gold amalgam is found in California and Columbia, having a definite composition, the former variety existing as yellowish white, four sided prisms. A native silver amalgam also exists, and may be explained in the same manner as the presence of silver in gold. There appears to be an immense quantity of gold amalgam in the bed of the Carson River, Nevada, and is brought up by means of steam dredges. Mercury and gold are also present in the Steamboat Springs of the same State. Even in quartz ledges mercury is found, some of the quartz geodes in the Pioneer Mine, Napa Valley, containing several pounds of the metal. At Sulphur Springs, Clear Lake, native sulphur exists in quantity associated with quicksilver ores, and native gold has been found in water-worn masses not far from the same locality. Although there is a strong affinity between gold and metallic mercury, there is none between gold and an ore of that metal, and the fact that they are found in combination is very strong evidence in favor of my view.

It does not seem likely that gold, whether quartz or placer, is derived from a chloride of gold solution. In many, many cases, there is no evidence of chloride having been present, and even so, that theory would not explain the presence of silver in combination with the gold, because that metal would probably have been precipitated as chloride of silver, and the gold itself thrown down in a state of fine division, by the action of iron or other reducing agent; and there is no other known solution of the metal that would satisfactorily explain the conditions under which it is found, especially the formation of crystals and its aggregation sometimes into large masses. In view of known facts, the theory of heat is inadmissible, nor is it probable that all placer gold has been derived from the disintegration of auriferous quartz, not only because of the greater average size of the particles found in alluvial deposits, but also because the latter is purer; at least such is the case in Australia, of the gold fields of which I have had some experience. There, as in this country, well defined crystals are found under such conditions that they must evidently have been formed *in situ*.

Admitting that gold is derived from mercury or some of its compounds, the various conditions under which it is found, as well as the presence of other metals, would be satisfactorily explained. As thallium is obtained from the mother liquor of salt works, the presence of gold in sea water can also be accounted for on this theory.

In order to prove the correctness of the theory, it is not necessary that those countries which contain large deposits of cinnabar should also have abundance of the precious metal. Diamonds are not found wherever deposits of carbon exist. There would have to be favorable conditions and the presence of various other substances, and it is probably not every ore of the metal that would answer for the purpose. I know by experience what important effects are produced in the compounds of mercury by the slightest trace of some other substance; the presence or absence of some slight impurity in the water or chemicals used modifying the expected results in a most perplexing manner. This is especially the case when experimenting with the salts of the metal for electrical purposes, as I have been doing for several years, it being discoveries made in that way that first caused me to consider mercury a compound; and although the reasons given to prove that such is the case, and that it consists of two known metals, may not be as convincing or conclusive as those given by eminent chemists in support of the view that not only mercury, but every other substance, consists of congealed ether, hydrogen, or some element not yet proved to have an existence, still I think the evidence submitted is entitled to consideration, even if it involves the necessity of admitting that those much abused individuals, the alchemists, might after all have been right.

A. C. COUSSENS.

THE RELATIONS OF TEMPERATURE TO HEALTH IN DWELLING HOUSES.*

By D. BENJAMIN, M.D., Camden, N. J.

WHAT is generally called a cold is always produced by some change of temperature, with or without moisture, to which a part or the whole of the person has been exposed. In most cases the change must be from a given temperature to a lower one, in order to produce a cold. One is more apt to take cold if a part, and not the entire body, be exposed to a low temperature. Dampness adds greatly to the power of a low temperature to produce a cold.

A cold is a disturbance of the circulation of the blood, whereby a part of the body has too little blood in it, and, therefore, some other part has too much.

The part that has too much is said to be congested, and if the congestion is not promptly relieved by treatment, inflammation is sure to follow. If in the throat, croup; lungs, pneumonia; bladder, cystitis, etc.

The human flesh is elastic and contractile, and, therefore, when cold is applied to a part it contracts, holding much less blood, consequently some other part must contain more than it should. Moreover, all vital action goes on more slowly in a low than in a high temperature, so that by cooling a part overmuch its nerve energy and vital force are greatly affected, causing delayed and dangerous reaction, or actual destruction of a part, while the undue blood in some other part of the body lights up inflammation that would not have been called into existence without this stimulus.

Cold applied to the skin generally produces congestion of the mucous membranes, because of their similarity of construction, nerve supply, and continuity of structure to the skin.

The most healthful temperature for the human body to live in is about 70° Fahr.

In a slowly moving atmosphere at 70° Fahr. a person cannot take cold, but a change of 10° Fahr., especially if it is sudden, is often sufficient to cause one to take cold.

The foregoing are undeniable truths, based on physiology, chemistry, and physics. Their importance and the practical application of them, especially in the pre-

* Revised from "Some Observations on the Relation of Dwelling House Windows and Temperatures to Acute Inflammatory Diseases," in the *Medical Bulletin*, May, 1886.

vention and treatment of diseases of the respiratory organs, we will now consider.

A few years ago I began making some observations and experiments on the circulation and temperature of air in rooms, with results which appear to me to be of practical importance.

The conditions of temperature and circulation of air vary greatly in rooms, especially those that are in use.

Fig. 1 gives results of experiments in a room ten feet high, twelve feet wide, and twenty feet long, with a

good stove and steady fire. Three-story brick house, south front, twelve rooms, warm cellar. Out-door temperature, 24° Fahr. By examination of Fig. 1, it will be seen that when the center of a room is 78° Fahr., four feet from the window it may be 70° Fahr., one foot from window 54° Fahr., and at window 40° Fahr. (no doors or windows having been opened for thirty minutes), a difference in the room of 38° Fahr.

In Fig. 2, a vertical section of same room, it will be seen that while the head is in 75° Fahr. the feet may be in 50° Fahr. What must be the effect on a person who

removes his warm boots and wears slippers, or the one that lies down to sleep on such a floor? Many do these very things, however.

Fig. 3 shows an every day occurrence among thousands, yes, millions, of people. A child three or four years old, from playing near a stove or on a nurse's lap, in a temperature of 70° or 80° Fahr., perhaps in a sweat, goes to a window and stands, without any change of clothing or protection, for half an hour or

more, in a temperature anywhere from 30° to 55° Fahr. How such a thing can occur without resulting in croup or pneumonia must be marvelous to any one who studies the subject even casually.

In many instances there is a small crack or opening either under the sash or at the side, and almost always at the junction of the upper and lower sash, where a stream of air is passing into the room nearly as cold as the outside air, though it be below zero. Cold air at a high speed striking a child directly on bare throat or breast can seldom fail to produce some dreadful disease.

On a very cold day, in some of the wooden houses in-

habited by poor people with many children and little time to look after them, children may often be found sitting on the floor in a temperature of 38° Fahr., or standing with nose against window pane at 20° Fahr., when the mother is washing or ironing in 65° Fahr. These people generally have but one fire in the house, and that in a cook stove, which cannot heat the floor at all, while cold draughts come from every other room, and especially from the stairway.

In churches and theaters the galleries will be 85° to 90° when the floor is 70° Fahr. Then the opening of a door or window is very injurious, and going out into the air at 10° or 20° Fahr. also causes a dangerous strain on the system.

In view of the principle already given, it seems to me that this is a striking state of affairs, and perhaps no principles of hygiene are so grossly violated as these. No wonder that the death list in Philadelphia alone in a single year reaches the dreadful sum of one thousand from pneumonia and about four hundred from croup (preventable diseases in most cases). It is also somewhat remarkable that the subject has not before been written up in medical works. The thermometry of hygiene and the sick room is a fruitful field for cultivation.

By reference to cuts, it may be seen that it is easy to be exposed in five seconds to a change of 40° Fahr., a circumstance that can never occur out of doors. In open air the temperature is nearly the same from head to foot, and changes much more slowly than in the house. A child gets off the bed and sits on the floor, a change of 10° Fahr., it may be 20° Fahr., or it goes to the window, possibly to scratch in the beautiful frost-work on the glass, a change sometimes of 40° Fahr. This explains why people take cold more frequently in the house than they do out of doors. In fact, I do not believe that people will take cold by habitually going out if they exercise and are properly clothed.

By reference to Fig. 4, it will be seen that when the first floor was as low as 48° and 50° Fahr., the second floor was 65° Fahr., and all the second floor room was

of a more even temperature. This is owing, of course, to the cold under the first floor and the heat, 90° Fahr., under the second. It shows why the sick should be, if possible, in the second story, over a room that is heated, and why relapses occur when patients are permitted to come down stairs. The contrast is greater in many instances than shown in the figure, which represents a grade of houses better than the medium.

Most of the foregoing experiments may be performed as follows: Take one and a half dozen thermometers (common japanned tin cases), set them in water very cold, 33° Fahr., and well stirred; ascertain the difference in the register, if any, and note it by pasting a little slip of paper with the correction on it near the top. Then place the thermometers all in water at 120° Fahr., well stirred, and correct as before; then in water at 70° Fahr., and correct. These corrections will render them sufficiently accurate for practical purposes. Lay six of them across the floor, or, better, on blocks one-half an inch high, in a row, equally distant one from the other, extending from wall to wall; then stretch a string or wire across the room in the same vertical plane as the row of thermometers, and hang another row on it right above the first; stretch another row across in the same plane at ceiling. You will then have three horizontal rows and six vertical rows. Wait thirty minutes, then read off the temperatures, and record them on a piece of paper to represent the vertical section of the room. Any number of such sections may be made in a room, and should be made to include windows and doors as a main feature. Temperature of windows can very easily be taken by placing or hanging thermometers on the sash.

It is clear from what has been stated that to keep well or to treat diseases, especially of the respiratory organs, such as pneumonia, croup, pleurisy, bronchitis, coryza, etc., we should keep an even temperature of about 70° Fahr. The thermometer should be on a level with the patient's head and near by; a good way is to hang it on the bedpost at the head of the bed, and the mercury should not be allowed to fall below 68° Fahr., or rise above 74° Fahr. If the floor is warm, the whole room can easily be kept so.

A bed should not be against a cold wall. If it cannot be in the middle of the room, it should not be near a window or door, and should always be pulled out from the wall six inches or more, so that the cold air, which always descends along a wall, can have room to drop to the floor without flowing over the bed. A great many cases of rheumatism and neuralgia come from sitting near a window.

I have often tried lecturing parents and nurses about

the importance of keeping children away from windows, but it is very often impossible to have the instructions obeyed. Windows are very attractive to children, especially when the weather is too severe for them to play out. Any woman's mind would be dreadfully strained who has her housekeeping to attend to if she were compelled to keep her eyes constantly on a number of children, even if she could compel them to obey when detected.

Some years ago I devised a contrivance to protect children from the death-dealing windows in cold weather which has given me, as well as parents, much satisfaction. It is simply a fender of metal (also made

of wood) about three feet high, and extending out from the window fifteen or twenty inches.*

In some families where I have had these screens arranged to the windows for one or two years, I have reduced the medical attendance very greatly, as my books will show.

In Canada many of the dwelling houses have double sash, glass about four or five inches apart, a very good device, and one that diminishes the coal bill also. They are a little unhandy to keep clean.

About two thousand cubic feet of fresh air is needed per hour for each individual in a room, and when no fresh-air registers are provided, can only be supplied through the keyholes and cracks around the doors and windows, making necessarily strong and dangerous draughts. The only resource left the physician, therefore, is the making of strenuous efforts to have people keep away from the dangerous places.

Leaving bedroom doors ajar or windows slightly raised in cold weather is sometimes dangerous, on account of draughts, and though it may be occasionally necessary, it generally requires more knowledge of sanitary science than is possessed by the masses.

On being called to see a case, I rarely find a thermometer in the sick room; its importance is not realized by the laity (or the profession). If there is one about, it is out of doors, or often good for nothing. The amount of ignorance in regard to the thermometer is remarkable. I often find people using one that is broken, and working against the pressure of the atmosphere instead of a vacuum. Once a lady said to me on my second visit: "Doctor, I don't see as that theomiter is any good; I've been a-watchin' it, and I had to use more coal to keep the room warm than afore I got it; I glist might as well a-throwed the money away." Still, I am in the habit of ordering a thermometer with the first prescription, though many would apparently pay five dollars for medicine more freely than twenty-five cents for a thermometer that might save ten times that amount.

No one can tell by his own feelings whether a room is warm or cold, for often you will see two persons contending in the same room, one that it is too warm, and the other that it is too cool. It is obvious that we cannot regulate for invalids or others by our feelings. The only unerring guide is the silent, sensitive little column of mercury.

The more rooms that are kept heated in a house, the less draughts will be found. Especially heat the halls; it will not take much more coal, and will avoid forcing your heaters or stoves, and enable you to keep easy fires. Keep the cold air from under the house also.

The artificial life of civilization causes greater susceptibility to colds at the same time that it exposes us to greater changes of temperature; but science enables us, on the other hand, to oppose with some success these pernicious influences. The study of this subject shows not only the varied principles that lie at the foundation of successful practice, but also the importance of the collateral sciences to medical education. And it is believed that even the few suggestions of this paper, if properly applied, would reduce the amount of sickness and death consequent upon the habitual neglect of easy precautions.

THE POISON OF THE STINGING NETTLE.

By ALFRED W. BENNETT, M.A., F.L.S., Lecturer on Botany at St. Thomas' Hospital.

SOME considerable time ago, I called attention to the unsatisfactory state of our knowledge respecting the fluid which gives the pungency to the stings of our common stinging nettles, *Urtica dioica* and *urens*, and pointed out the difficulties in the way of accepting the ordinary theory that it is due to formic acid. Dr. G. Haberlandt, in a paper on the "Anatomy and Physiology of Stinging Hairs," read before the Academy of Sciences at Vienna, has now given the coup de grace to this hypothesis, showing that formic acid has no such virulent properties in the minute quantities in which alone it could be present in the stinging glands of the nettle; and that the irritation must be produced by a fixed substance, since the

* At my request Mr. C. F. Hollingshead, of the Cooper's Point Iron Works, has prepared some very convenient and ornamental designs.