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Contents:

(Illustrated articles are marked with an asterisk.)

WANTED A SUBSTITUTE FOR EARTH AND PLASTER WALLS.

In the matter of external construction, the architecture of the civilized and semi-civilized races shows a very marked contrast to the rude habitations of savages; but so far as inside walls are concerned we are but little removed from them. We daub the insides of our dwellings with what if not exactly mud is but little removed from it. In this respect our civilization is but little above that of the beaver, the mason bee, or the mud wasp. It seems strange that in this age of improvement, the public is content with the rude plastering, the earliest date of which would be about as hard to fix as the date at which building began.

Mortar is ill adapted to the purpose in several respects. First, it is uncomely, unless covered with hard finish or paper, or frescoed in a much more artistic manner than most modern fresco painters seem capable of. Second, it is friable and inelastic. A slight inequality in the settling of buildings fills it with unsightly cracks, the repair of which fills a dwelling with dirt, ruining furniture and irritating temper. Third, a certain temperature must be maintained after it is applied until it is dry, to obtain a successful result. Fourth, it is liable to fall from the ceiling upon the heads of people quietly and unsuspiciously sitting beneath it, from the effects of jar or an undetected leak in the roof. Fifth, it is a porous and absorbent material, and forms, unless covered with hard finish, painted, or otherwise covered, a reservoir for the accumulation of noisome odors and pestilential effluvia, etc.

Standing opposite these objections it has the advantages of cheapness and easy application, which do not in our opinion balance the account.

It would seem that with all the resources now at command something much better than mortar may be found out of which to construct inside walls; something not so expensive as wooden wainscoting and ceiling, while at the same time it might be susceptible of a high degree of adornment, and free from the objections we have enumerated.

We believe an excellent, warm, and durable wall might be made of straw board, sized with glue, or some other permanent stiffening, and painted on the inside. This material has considerable strength and elasticity. It is a bad conductor of heat, and would not condense moisture from the air in cold weather, as is frequently the case with plastered walls, in churches and assembly rooms, when an audience assembles in them.

Nothing can be more unsightly than the streaks formed by condensed moisture on a frescoed wall, unless perhaps it may be the streaks of color sometimes seen on the cheeks of ladies in overheated assembly rooms.

It is even possible that a preparation of straw pulp could be made that might be applied in a plastic form; a sort of straw *papier mache*, capable of being molded into forms of beauty in cornices, center pieces, etc. Such a wall would seem to be inexpensive and easily put on, it would not be attended, in repairs, by the disagreeable and destructive lime dust. If varnished over the paint, it could be easily kept clean by washing, and any colors desirable might be used in its decoration.

There are other materials which will suggest themselves to inventors as being likely to prove available for the purpose, and there can scarcely be a question that the public would eagerly embrace any improvement that would secure immunity from the objectionable features of plastered walls. But perhaps the material which will soonest be thought of in this connection is sheet metal. We are informed that ceilings of corrugated metal have been manufactured, but we do not know the parties who make them, nor have we learned the success which has attended their use. It must be remembered however, that metallic bodies conduct and radiate heat with greater facility than other substances, and are therefore perhaps open to some objections on the score of economy in cold climates where a saving in fuel is a desirable attainment.

To find a substitute for mortar, every way answering the requirements of the case, will undoubtedly necessitate some experiment, but we believe the value of such an improvement would warrant the devotion of considerable effort toward its attainment.

WANTED---LIGHT IN DARK PLACES.

While the means of creating artificial light have received much attention, and have been greatly extended within a few years, we find city corporations still clinging to common illuminating gas for lighting streets, railroad companies using kerosene for lighting stations and tunnels, and the United States Government holding on to the lard oil lamps for lighthouses. We have seen only one indication that anything better than gas is sought by city governments in this country for street lighting. This indication is found in the annual message of Mayor Hall to the Common Council of New York, which contains a suggestion that the magnesium, or, more properly, magnesia light—for this must not be confounded with the light produced by the combustion of the metal magnesium—might prove cheaper and better than the gas now used. The light in question is produced by the combustion of two small jets of gas, one of ordinary illuminating gas and the other of oxygen, in contact with a pencil of magnesia. It is precisely similar in principle to the well-known lime light; the substitution of magnesia for lime on account of its superior durability, and common illuminating gas for pure hydrogen on account of its cheapness, being all the modifications made, if we except the improved burners intended for general use. The process of Du Motay has so cheapened the cost of obtaining oxygen that the light thus obtained is rendered cheap enough for general use.

The want of diffusiveness complained of in the lights of this kind, placed at the corners of Trafalgar Square, in London, does not appear to us an essential defect of this light, and we are of the opinion that proper adjustment would entirely obviate any such objection.

We are assured by Dr. Doremus that the city streets could be illuminated far more cheaply and efficiently by the magnesia light than is possible by the old method.

It is also demonstrable that the safety of life and property is enhanced by thoroughly lighted streets, while the comfort of the populace is greatly increased.

But while it needs no argument to show the superiority of the magnesia light over the ordinary gas, we think a suggestion in regard to the placing of lights, of whatever character they may be, is worthy of consideration.

In approaching one of the ordinary gas lamps the eyes are so dazzled by the direct rays from the burner, slightly elevated above the heads of foot passengers, that a person, although his face may be perfectly recognized by another coming from the light toward him, cannot recognize distinctly any one a few feet in advance.

A remedy for this occurred to us one evening during the past winter, when upon the occasion of a *fete*, held in the Academy of Music, on Fourteenth street, in this city, the street for several blocks was illuminated with the magnesia light. The light being placed at quite an elevation, there was considerable diffusion of the light through the atmosphere approximating the effect of daylight. The faces of people coming from the light were as readily recognizable, as —when we had passed it—were those of people approaching it. The light, although very dazzling to look at from a short distance, was above the line of ordinary vision, except at a considerable distance, which so tempered it that its dazzling effects were not felt. Our observations at the time convinced us that the elevation of street lights would not only add to their general illuminating power but would render their effect much more agreeable.

The adaptation of the magnesium light to the illumination of dark tunnels on railways, seems not only obvious, but, it appears to us, demands the attention of railroad managers, from its economy, efficiency, and the increased safety which would be secured by its adoption.

For example, the Bergen Tunnel, on the Erie Railroad, a short distance from the ferry in Jersey City, has trains passing and repassing nearly every half hour of the day. It is three quarters of a mile in length. It is the custom to light the lamps in the cars when a train is about to enter this tunnel and extinguish them after the tunnel has been passed. The rushing into this darkness from broad daylight, produces a very uncomfortable sensation. This annoyance to passengers might be obviated, and the trouble of lighting lamps be done away with, by a suitable disposal of a few magnesia lights, which would light up the entire tunnel. We are certain that the adoption of this suggestion would be hailed with satisfaction by the crowds of people who daily pass through the Bergen Tunnel.

What reasonable excuse can be given by the Government for neglecting the advantages of this light for lighthouses along the coast, we cannot conjecture. In power it is as much superior to the lard oil lamps as they are superior to total darkness. When it is reflected that the loss of a single loaded vessel would supply the lighthouses along the entire coast with the new light for a long time, it is hard to conceive why our Government should not at once gladly avail itself of a means whereby immensely greater efficiency could be at once secured.

Many of our city readers will remember the humorous and sarcastic manner in which Prof. Doremus spoke of some of the officials who have this matter in charge, at his lecture on the Photometer, before the American Institute last winter, and the hearty laugh which burst from the audience on that occasion, when after the hall had been flooded with the magnesia light, he made the simple announcement that the government officials above alluded to, thought on the whole, lard oil was the best thing for the lighthouses. We heartily wish Professor Henry, of the Smithsonian Institute, whose intensely old-fogy letter upon the subject was read by Dr. Doremus, could have been present on that occasion. He would have found the lard-oil party decidedly in the minority at the moment.

But we have said enough for our purpose at this time. The whole matter may be summed up by the plain assertion that the public want, and will have, better light than is at present provided by tardy officials.

SPONTANEOUS GENERATION.

Discussion upon this topic seems to have been revived in some quarters. Most of our readers will understand what is meant by spontaneous generation, but lest there should be any misapprehension in the minds of any we will state what we understand by the term.

It certainly does not mean the springing into existence of living beings without any cause or causes for such an event; but, as we understand it, it signifies the production of a living thing from the elements which enter into the composition of its tissues, without the previous existence of parents and the formation of a germ through the action of vital energy, which, in general, is the commencement of reproduction.

It is not to be denied that the tendency of modern science is to the belief that spontaneous generation is possible, though if so, rare, and occurring only in the lower forms of life, under circumstances very difficult to separate from those which tend to obscure, and defeat demonstration. Notwithstanding all attempts at positive demonstration have hitherto failed, there remain some stubborn facts very difficult to reconcile with the belief that spontaneous generation can never occur.

Our readers will recollect reading of the appearance of certain insects of the *acarus* tribe in a highly caustic solution upon which the celebrated English electrician, Andrew Crosse, was experimenting in 1836. A considerable sensation was caused by the discovery, and a sharp discussion followed as to whether the appearance of the *acari* was an example of spontaneous generation or otherwise. The wife of Mr. Crosse has testified since his death that he never so regarded the occurrence, although surprised and nonplussed by it. Professor Faraday and Mr. Weeks confirmed the experiment of Mr. Crosse, but it has since been repeated by Professor Schulze, of Germany, without the appearance of the *acari* or anything resembling a living germ.

Others, among whom the most prominent is perhaps M. Pouchet, have endeavored to demonstrate the possibility of spontaneous generation by actual experiment, but though they have performed their experiments with much care and have succeeded in finding in their solutions many new infusoria, they have not generally convinced the scientific world of the satisfactory nature of their experiments.

The views of Professor Fick are that every organ of living beings is formed of congeries of cells, that each of these cells has a separate and distinct existence, and that, could proper conditions be attained, these cells would preserve their individuality of existence, and continue to live though the body of which they form a part were dead.

Professor Clarke, in his investigations upon the origin of *vibrios* from decaying muscle, says that he was impressed with the thought "that the *vibrios* were neither more nor less than the fibrillæ of the muscle set free from the fibers," a suspicion which he says was eventually verified by actually witnessing the fibrillæ disentangling themselves. He concludes, however, that the *vibrios* are nothing but dead muscle, notwithstanding their active motions.

A writer in *Scientific Opinion* now takes the ground that these are or may be living organisms; and accounts for the organisms found in the infusions of M. Pouchet and others, by the assumption, that they are simply the re-arrangements, and re-combinations, of the liberated cells of the substances infused; basing his views on those of Professor Fick above alluded to.

Now it is certain that every germ is a living entity, and that it is composed of matters found in the inorganic world. These matters have been combined by some means, and the compounds blended in the tissues are of a chemical character, yet possess a certain undefined something which merely chemical compounds, so far as present knowledge extends, do not possess, but which has received the name of vital force.

This force is synthetic in its nature; it builds up tissue, or it enables tissue to build up other tissue like itself. Hence we have growth, and when the vital energy decreases, or ceases, we have decay of parts, or general death and decay. While it is not proved that vital energy is not identical with chemical affinity, there are many reasons for believing it to be a distinct property belonging only to living things, and capable of being imparted only by living things to combinations of dead matter which thus becomes quickened. There are, at present, too few data for determining the question at issue, and while the subject is one of intense interest, and presents a most captivating field for study and speculation, it is one upon which it is absurd to hazard an opinion at present.

However deep we enter the penetralia of nature, there yet remains something between us and the ultimate; and all analogy teaches us that this must ever be the case. Every new discovery only leads us one step nearer the great controlling intelligence, who infinitely removed from mortal ken, yet permits us to approach gradually, through the ages of eternity to the secret of omnipotence. How vain, therefore, to assume from the few facts which biological science has already attained and classified, that we have even caught one glimpse of the profound mystery of life.

HAIL AND HAILSTORMS.

Our exchanges give accounts of several hailstorms which have occurred in various parts of the United States, and we are in receipt of several communications concerning the principles which govern the formation of hail, and containing some inquiries in regard to them.

Among these, a fair correspondent from Otsego Co., N. Y., has asked us whether a genuine hailstorm was ever known to occur in the night. Several others write us in a way that shows a confusion in their minds as to what is to be considered a hail storm, and what is not.

We will answer several of these together by saying that the sleet which falls in cold weather, and, in some regards, resembles hail, is not genuine hail. If a granule or globule of sleet be examined, it will be found to be generally of uniform texture throughout, being simply an ice globule. A hailstone, on the contrary, is formed, generally, of alternate layers of ice and snow, arranged somewhat like the layers of an onion, around a white nucleus of snow.

It is stated in the books,that hail rarely occurs in the night. In our own experience, a hailstorm has *never*, to our knowledge, occurred at night. Our numerous correspondents, who reside in regions liable to the occurrence of hailstorms, will confer a favor by informing us if they have seen genuine hail between sunset and sunrise.

These storms usually occur during the hottest weather, and in the daytime, generally, if not universally, accompanied by electrical displays of great activity. It is quite certain, therefore, that electricity is, either as a cause, or effect, or concomitant, connected intimately with the production of hail.

During the occurrence of two hailstorms, which occurred at this point this season, we examined some of the stones which fell, and, whether owing to the warmth of the pavement, acting to speedily melt them, or to some other cause, the form of the stones did not present the usual pear-shaped form very distinctly.

The Transactions of the American Institute, for 1864, contain an account of a hail storm which occurred in Paris on the 29th of March, of that year, in which the stones had an absolute conical form. The base of the cone was slightly concave, and the sides were roughened by minute, six-sided, transparent pyramids, inclined toward the base. Some pyramids, also, emerged from the base. The weight of these cones varied from 180 to 250 milligrammes—about from 28 to 38 gr., —and the diameters of the bases varied from 8 to 10 millimeters, or from about 3-10 to 4-10 of an inch; while the hight was from 10 to 13 millimeters, or from 4-10 to 5-10 of an inch. The hail, was, therefore, remarkable in nothing except the form of the stones.

The combination of causes which produce hail are very imperfectly understood. There must, however, be contact of cold air with warm, moist air, but how the intense degree of cold necessary to change the condensed watery vapor into, ice, so rapidly, is produced, is yet a mystery. All the theories yet put forth are based upon hypothesis, and it is difficult to see how facts can be obtained which will give a reasonable solution of the phenomenon.

The freezing takes place at points inaccessible to man and the lumps of ice are precipitated upon the earth, frequently in such a manner, and of such a size, as to show that they must have fallen from high altitudes.

The theories alluded to are so familiar to most of our readers, that we will not dwell upon them, but will say in conclusion, that the most plausible of them appears to us to be that of Redfield,which supposes the hot and cold airs to be mingled and carried to high and intensely cold regions by the action of a vortex or whirlwind, from whence the congealed moisture is precipitated in the form of hail.

THE PRACTICAL APPLICATION OF THE SLIDE VALVE AND LINK MOTION TO STATIONARY, PORTABLE, LOCOMOTIVE, AND MARINE ENGINES.

The above is the title of a new book from the pen of William S. Auchincloss, C. E., which is a work of too great importance not to receive at our hands more than the brief notice usually accorded to new publications.

The author tells us in his preface that

> the main object of his treatise is to place in the hands of the mechanical engineer and draftsman, a simple method for determining the proportions suitable to any link motion, without the assistance of an expensive and cumbrous model or the delays incident to its manipulation. Secondarily to supply the student of steam engineering with a comprehensive view of those causes which regulate both the form and dimension of the cylinder, slide valve, and eccentric. This portion of the work has grown incidentally out of the first; for as the link merely combines the action of two eccentrics, it was obviously necessary that the functions of one of these should be clearly understood before an attempt was made to develop the laws of their joint action.

The author modestly expresses the hope that these Parts I. and II. will not prove entirely devoid of interest to the skilled designer, but that they will at least receive a hasty survey, for the sake of the light they throw on the general subject through the medium of Part III. The author may dismiss all fear that any part of his able work will fail to interest either skilled or unskilled readers. We have seldom had the pleasure of reading a work, in which the author has been able to express himself with greater clearness, or has reached the real difficulties of his subject by such well-selected methods of approach. There is in the body of the work no shadow of an attempt to sacrifice perfect plainness of speech to a desire to display the learning of the author. He has, from the out set, conscientiously kept but one purpose in view; namely, to choose only those methods of demonstration which would best enable his mind to come in contact with the minds of his readers. To this end he has never let style or pompousness of expression take precedence of perspicuity, and has been willing to adopt any method of illustration, however simple, provided it would best subserve the purpose. In this way he has stamped his personality so strongly upon his work that one feels, after perusing his work, as though he had held a conversation with the author, instead of reading a book.

He is fully aware, at the outset, that

> engineers, accustomed to consider the model as absolutely indispensable to the proper adjustment of a link motion, will be wont to look with skepticism upon all efforts made to solve the problem by other means,

and admits that

> so far as these feelings are entertained against an algebraic or trigonometric solution they are well based; the number of variables entering into the problem, being too great for the powers of algebraic expression.

He has, therefore, adopted geometric construction as the basis of his system, and has shown great skill in its development. But while in his treatment of the subject the author has judiciously avoided all abstruse modes of expression, he has added, in the appendix, a mathematical investigation of the subject of the crank and piston motion.

The results of the investigations and discussion enable the author to construct a travel scale, by which all problems connected with the slide valve can be directly solved by simple measurement, and without any complicated construction or calculation.

The author commences his work by a brief but sufficiently comprehensive discussion of what is to be correctly understood by the term work, and the methods of estimating it. He then takes up the subject of mean effective pressure, and shows that

> the character of the connections between the boiler and steam cylinder, their length, degree of protection, number of bends, shape of valves, etc., must all be considered in forming the initial pressure in the cylinder, while the mean effective pressure will depend upon the point of cut-off of the steam, and the freedom with which it exhausts.

He does not attempt the discussion of the proper point at which steam should be cut off, that being foreign to the purpose of the work; but considers it throughout the treatise as predetermined, with the exception of certain limitations prescribed by certain valve motions.

This is followed by a mean pressure, volume, and temperature table, in which the stroke, being taken as a unit, and the initial pressure in lbs., with the temperature in degrees, Fah., and the corresponding relative volume being given, the mean pressure for various points of cut-off may be at once taken off.

> If from the mean pressure we subtract the mean value of the back pressure, or that which may arise from imperfections in the exhaust usually taken for low-pressure engines, at from one to two lbs. per square inch, the resulting pressure will be the mean effective pressure in pounds exerted on each square inch of the piston.

This, in connection with a large number of experiments made by Mr. Gooch, in 1851, with the locomotive *Great Britain*, forms the basis for another table of mean effective pressures. The author here, as well as in all other parts of the work, illustrates by an actual example performed in accordance with the principles laid down, the proper application of the principles to the solution of problems.

The next subjects considered are the speed of piston, diameter of piston, and its stroke. Here it is plainly shown that the diameter of the piston to drive a given horse-power depends upon the mean available pressure and its speed, the latter, of course, left to be decided by the judgment of the designer, as formed upon a due consideration of each individual case. The author, therefore, contents himself with giving the quantities most frequently found in ordinary practice. Of course the stroke of the piston is derivable directly from the speed of the piston, but the circumstances which should limit the stroke are referred to in this connection, accompanied by tables of the revolutions made by driving wheels of a locomotive at given speeds, for various diameters, and the number of revolutions of cranks of marine and stationary engines, for given stroke and (approximate) piston speed.

As all work performed depends primarily upon the mean effective pressure in the cylinder, and as this mean effective pressure so far as the engine proper is concerned, depends chiefly upon the point of cut-off and the freedom with which the exhaust takes place, the author justly remarks, that

> the area of the steam port ranks next to cut-off in its controlling influence upon the proportions of the valve seat and face. It may, therefore, be considered as a *base* from which all the other dimensions are derived in conformity with certain laws. Its value depends greatly upon the manner in which the port is employed, whether simply for admitting the steam to the cylinder, or for purposes both of admission and exit. In cases of admission it is evident that the pressure will be sustained at substantially a constant quantity by the flow of steam from the boiler. But in cases of exit or exhaust, a limited quantity of steam, impelled by a constantly diminishing pressure, forces its way into the atmosphere with less and less velocity. If, then, the engine is supplied with two steam and two exhaust passages, the ports will be correctly proportioned when the areas of the latter exceed those of the former, by an amount indicated by careful experiment. When, however, one passage performs both duties, it should have an area suitable for the exhaust, and be opened only a limited amount for the admission of steam. Very excellent results have been found to attend the employment of an area equal to 0·04 of that of the piston, and a steam pipe area of 0·025 of the same, when the speed of the piston does not exceed 200 feet per minute, but widely different factors are demanded by higher speeds, like those peculiar to locomotives.

The experiments of Gouin, Le Chatelier, Clark, Gooch, and Bertera, are then considered, and a table constructed for the relative proportions of port area and steam pipe area, expressed in decimal fractions of the area of the piston for various speeds of the piston.

> Having determined the area of the steam port, the next step is to resolve it into its factors, length and breadth. When a small travel of the valve is essential, the length should be made as nearly equal to the diameter of the cylinder as possible: then the port area, divided by the length, furnishes, of course, the value of the breadth. *The extent to which the valve should open this port for the admission of the steam will equal from 0·6 to 0·9 of the breadth*, and the *minimum* travel, that which, with a given cut-off, just opens the steam port the amount of this limit. The *maximum* travel is governed by expediency, the general tendency of an excess over the minimum is to render the events of the stroke *more* decisive, the cut-off takes place with greater brevity, avoiding unnecessary wire-drawing of the steam and the release opens rapidly, affording a more perfect exit. Where the travel is small these good qualities should be secured by increasing this term, until the valve gives an opening equal to, or greater than, the width of the steam port. With a large travel no such attempt should be made, since it would inevitably sacrifice much work in friction and cause a far greater loss than gain.

The form of the upper valve edge here comes in as an important combination, and it is shown that a proper curvature is preferable to the more common angular form for the exterior edge.

Having thus established an intelligent basis from which to deduce the motions of the valve and its attachments, namely, the point of cut-off, and the area of the steam port resolved into its factors of length and breadth, the author proceeds to discuss the means whereby the proper motions may be ascertained and secured. In doing this his method is admirable. He begins by supposing the valve to be actuated by a crank, its pin playing in a slotted crosshead attached to the eccentric rod, and also supposing the crank on the main shaft to be actuated by a slotted crosshead acting on the crank pin. This divests the problem of all complications arising from angularity of the crank and eccentrics at half stroke, occurring when the ordinary connections are used, they being reserved for subsequent study, when the general principles of the primary motion shall have become well understood. For convenience the cylinder is always regarded as being on the *right-hand* side of the main shaft, and the point of the crank pin circle *nearest* to the cylinder as the zero or starting point of the stroke. Then follows a table of positions under these conditions, with examples showing its application. From this point of departure the author proceeds gradually forward, clearing away obstacles and rendering the ascent easy to the most complicated portions of the subject.

We have dwelt upon the earlier portions of the work because we are convinced that only by a proper appreciation of the judicious selection of the elements of cut-off, and steam port area, as a basis, from which all the required motions are most easily traced, will the reader be prepared to follow the author through his subsequent train of reasoning with pleasure or profit.

We wish we had space to here review the subsequent portion of this able treatise, but we assure the reader that we have never opened a work relating to steam which seemed to us better calculated to give any intelligent mind a clear understanding of the department it attempted to discuss. The work is profusely illustrated with diagrams and plates, and the travel scale, the offspring of the thought and study which originated the work, is affixed.

The work is published by D. Van Nostrand, No. 23 Murray street and No. 27 Warren street, New York.

THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY.

The following report of steam boiler inspections by this company in the month of May, is made to its directors:

During the month 265 visits of inspection have been made and 437 boilers examined—359 externally and 204 internally —while 23 have been tested by hydrostatic pressure. The number of defects in all discovered, 53—28 of which are regarded as especially dangerous. These defects were as follows: Furnaces out of shape, 7; fractures in all, 219—5 dangerous; burned plates, 27—1 dangerous; blistered plates, 39 —3 dangerous; incrustation and scale, 65—3 dangerous; external corrosion, 67—4 dangerous; internal corrosion, 6; internal grooving, 1; water gages out of order, 20; blow-out apparatus out of order, 3—1 dangerous; boilers without blow-out apparatus, 4; safety valves out of order, 13—2 dangerous; steam gages out of order, 36—4 dangerous; boilers without gages, 12; manholes without mouth-pieces, 6—2 dangerous; boiler heads not properly stayed, 9—2 dangerous; boilers condemned as unsafe and beyond repair, 2.

We are frequently asked what is to be understood by "furnaces out of shape?" We suppose that few persons familiar with steam boilers fail to understand this. It is well known that the furnace of a steam boiler is subjected to intense heat, and consequently the iron is liable to excessive expansion. Where injudicious firing is done this is especially true, and we not unfrequently find sheets contorted, their joints badly strained, and a complete overhauling absolutely necessary for safety.

Injudicious firing is a very prevalent evil. Where coal in large lumps is piled upon the grate nearly or quite to the crown sheets, the furnace cannot be otherwise than seriously