## IRON COMBINATION BEAMS FOR BUILDINGS.

Messrs. Editors:—In answer to your recent call for practical information on the use of 9-inch "I" wrought iron beams of 17 feet span in the construction of the floor for a drill room, I will say that, notwithstanding the fact that such beams are used quite extensively in the ordinary floors, yet I think they are not the best, and that they are not suited to the severe use of a drill room. They will probably be too flexible, they ought to have more depth, say 13 inches, which is equal to that of the brick and concrete work. Another kind of beams, of 13-inch depth, can be made that will have full one-third more strength and stability; they will answer all the requirements of this floor, and cost no more than the 9-inch beams. I mean such as I described in Vol XIV. (old series) of the Scientific American, commencing page 62, and the tests of which were published on page 117, this volume. The question of merit between the two kinds of beams can be determined by trial, or by a comparison of the published results of tests. But as the superiority of these beams is due to a wide departure from recognized or popular theories on this subject, it may be well to show in what respect they differ, and wherein their merit consists.

The question of beam construction has become sadly mystified by authors who have advanced fallacious theories in advocating their own notions. As most of the fallacies of writers on this subject have been adopted by Mr Fairbairn, and concentrated in his late work on iron beams, I will direct my attention mainly to this. What I consider as one of his greatest errors, and second only to that of his theories relating to forces and forms (already discussed in Vol. XIV., Scientific American), is his advocacy of an exclusive use of wrought iron in the construction of beams, girders and bridges, simply because this material possesses high tensile strength; also, because he condemns the use of cast iron for any part of such a structure, for the reason that its tensile capacity is low, though its capacity to sustain pressure is known to be very great; as if this latter quality was not as important as the other in structures where the pressure is as great as the tension, and in which these two forces are nearly distinct and opposite in their action. His theories on this point are delusive, and at variance with common practice—even with his own. Although it may be supposed by many that the Britannia and other tubular bridges, in the construction of which Mr. Fairbairn has taken part, are composed of wrought iron, they, in fact, contain hundreds of tuns of cast iron, used for the purpose of *strengthening the wrought iron tubes.* Nearly all iron structures of considerable extent (certainly, the best of them) contain a large proportion of cast iron. Notwithstanding the well-known and extensive use of cast iron in columns, large rafters and in upper chords of girders and bridges of the highest importance, where the action upon the parts are mainly compressive, Mr. Fairbairn says (on page 54 of his work) that, "even where *well*-proportioned, *it* will suddenly snap without any apparent cause." But then (on the same page) he shows that such results are due to *bad* proportions. On page 56, in speaking of defects in cast iron from scoria, he says: "This *can never* occur in wrought iron beams;" then, in the fourth line after, he admits that "it *will*, however, sometimes occur." These are a few of the inconsistencies and contradictions with which his work abounds.. His views are veiled in a plausible garb, and the more superficial reader cannot detect their real character; but this will not do for the practical engineer, who has to deal with hard and uncompromising realities.

Experiments with purely cast iron beams are of but little practical consequence, as this metal in this form is neither good nor economical; it is wholly unfit for the duties of the lower chords, owing to its low tensile capacity But, on account of its superior power to resist pressure, and the facility with which it may be molded to any form, it is peculiarly well suited to the opposite duties belonging to the upper chords, while wrought iron is, on account of its great tensive capacity, best adapted to the duties of the lower chords. These being the facts of the matter, it is absurd to advocate the exclusive use of wrought iron in the construction of beams, in which the strains are as opposite in their character, as well as in the direction of their action, as is the quality and nature of these two kinds of iron. As their qualities are opposite, and each is suited to the opposite duties of the upper and lower parts of beams, there can be no good reason why they should not be thus used in combination. It is done extensively, as before stated; and successfully, too, notwithstanding all the specious teaching to the contrary. Using one form, such as the rolled "I" beams alluded to, and having the section of both chords uniform and parallel with each other, for various and opposite purposes, is certainly not consistent with good construction. Such practice, in other professions, would very properly be called "quackery" or "monomania." It has been said that the difference in the contraction and expansion of cast and wrought iron must preclude their use in combination. This objection is rather fine spun. The difference between them is a little less than .009 of an inch in a length of 20 feet, in consequence of a change of 60° of temperature; this is hardly discernable by unaided eye-sight. The parts of beams are seldom made as nearly of one length in practice, it requires good workmanship to do it. It is less than 1-10th of an inch in a length of 100 feet, and is readily and imperceptibly overcome by a slight and unimportant compression or extension of the parts; therefore, it is of no consequence in practice, and it is a pity that learned theorists have attached so much importance to it. As to the objections urged against cast iron on account of possible defects, arising from air-bubbles or scoria in it, it is only necessary to say that these objections have no weight with practical men, for they know how to prevent their occurrence. And if, in consequence of neglect or mismanagement, there should be any of such an extent as would seriously injure the part, the faithful attention and supervision of a practical engineer will be sure to find them. This is a matter that is completed under the control of the engineer and founder, and when they understand their business there is no danger; as men of observation and practice well know. But, admitting that slight defects of this kind may occur, say in a cast designed for the upper chord of a beam, and that it is equal to 1-6th of its entire transverse section, this would not endanger a properly proportioned structure, for there will then still be 5-6ths left to be crushed before it can fail; but this will not be possible, because the force will be only about 1-4th or 1-5th of what would be required for this purpose. It is to guard against just such possible contingencies that we make the size of the parts equal to five or six times of what the applied force can crush. The defects incident to cast and wrought iron are of as opposite natures as are the purposes to which it is proposed to confine their use in beams—the defects of each are least injurious when they are thus used. A slight defect in the cast iron of a beam will not seriously impair its effectiveness; and as the defects in wrought iron are usually in the form of splits or laminæ, these, when not extensive, will not seriously impair its tensile capacity in a lower chord. Such a defect, however, when the part in which it exists is used to sustain pressure, is very bad; wrought iron should not be used in upper chords, for the pressure of these will cause the split or laminated part to "buckle." This and other facts and principles of equal importance are often overlooked or neglected in practice, especially when the work is designed and directed by those who are not familiar with such matters. To illustrate this fact, I will state that a learned and eminent engineer in this country had occasion to construct a wrought iron roof of considerable span, and knowing that the amount of force required to crush and to tear this material asunder by tension is about equal; and knowing, also, that the amount of pressure in the upper chords is about equal to the tension of the lower chords, he made the section of the rafters and the ties or lower chords also about equal, thus making their sizes to correspond with the ultimate tensile and crushing capacity of this iron, though it is calculated that the actual strain will never exceed 10,000 pounds to the inch. Now, these proportions seem fair in theory, and I believe this roof has been inspected and admired by many engineers of the highest eminence; yet it is only necessary to call the attention of a thoroughly practical engineer to the arrangement of the parts to convince him that the rafters will, for want of proper lateral support, deflect from their normal direction, buckle, and fail under the action of a load that is less than half of what the ties can bear with safety. The roof, however stands as yet, because there is a great excess of material in it. I allude to it only to show how a bad distribution may affect its capacity, and to indicate how similar blunders may be avoided by considering, not so much the ultimate capacity of the material as what it will bear *in the manner used.*

B. Severson.

[To be continued.]

## SAVE THE SAWDUST!

Messrs. Editors:—As *utility* seems to be one of the characteristics of the day, it may interest the inexperienced to know how to make that ever-growing "pile" (of sawdust) a source of profit. For years I have not wasted any of it, and find its use the saving of a large per centage of wood. Our mill has a 42-inch boiler, 22 feet long, 2 return flues, and set so as to conform to the principles of the formula given by Joseph E. Holmes on page 315, Vol. X. (old series) of the Scientific American. The cylinder is 10 by 50 inches stroke, cutting off the steam at half stroke, and the motion regulated by a Judson valve. The engine makes about 80 revolutions per minute, driving a 7-foot muley saw and one of J. E, Holmes' circular mills, with 30-inch saw, making 300 revolutions per minute. The steam blows off at 120 lbs.; using green wood and burning all the walnut, oak, poplar or gum dust the mill makes, and easily maintaining the steam at the point named. Cypress dust contains more water than any we have; and once I had a lazy fireman who thought he could not burn cypress, and so he let the pile grow until it frightened him away from the mill, when I took the shovel, and in three days caught up.

Several years practical work has taught me that sawdust needs a tight fire-front, a strong draft through the grates, wood to prevent its packing, unless the boiler is longer than the usual size, and the chambering alluded to above, in order for the gaseous matter to reverberate and produce a perfect combustion. After our furnace becomes heated, the utmost crowding of dust does not show the *least sign* of smoke at the chimney top; this non-appearance is the most conclusive evidence of perfect combustion. In firing dust never stir it, unless it be with a small rod, to make a road for the flame; and after firing half a day without stirring, I have gathered as perfect cinders as from the smith's forge. I have taken the shovel from an inexperienced hand when steam was down to 75 or 80, and gradually raised it to the blow-off point with little besides dust.

I once visited a friend who was carting all his dust out from the mill, and on asking the fireman why he did not burn it, I was told: "It smokes the fire out," and from the small space underneath the boiler, it was quite evident the gaseous matter would be half strangled in "running the gauntlet" to the outer world. I sketched the plan alluded to and gave my friend the reasons why that must come nearer, producing a perfect combustion. He ordered the mason to re-construct the walls, but he (true to the way he had learned) at first refused, and nothing could convince him of his prepossession but the sight of the living flames rolling over the walls and filling the chambers, and that from the same kind of dust that was said to have smoked the fire out. In two months I saw my friend again, and he said that all the dust went under the boiler with ease; and in that time the slabs, as they were thrown off, had reached the top of the first story of the mill; it not needing them, while before it took all of them. If possible, let some one who has handled the dust-shovel show a more perfect way of economy of fuel.

J. L.

Smith's Mills, Ky., March 14, 1860.

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Rain Water not Absorbed by Leaves.—It has always been thought that the rain water which falls upon the leaves and stems of vegetables is gradually absorbed, and nourishes the plant. It appears, however, that this opinion is merely instinctive, and when tested by careful experiment, it proves unfounded, as is shown by a small paper lately published by M. Duchartre. For four years this author has endeavored to discover, by direct experiment, whether or no such absorption takes place. The plants submitted to these experiments were in pots, their stems and leaves being exposed to the rain, whilst the roots were prevented from absorbing any moisture, being hermetically closed up in the pot. All the plants submitted to this kind of investigation gave similar results; after remaining exposed to the rain, sometimes for eighteen consecutive hours, they showed no increase in weight; indeed, in some cases, they appeared to have experienced a slight diminution.—*London Photographic News.*