STEEL MINE RIG.

BY HARRY J. LEWIS.

The very material reductions which have taken place in the price of structural steel work during the two years just past, place within easy reach of mine operators a type of outside rig which has heretofore been considered a luxury. Some of the first experiments in the use of steel structures have not been entirely satisfactory because the purchasers did not place the matter in competent hands and in consequence obtained, in some cases, a framework which was ill-designed and entirely too light for the work it had to perform, and in other cases they were loaded up with a lot of unnecessary material. The first case is by all means the poorest bargain of the two, as the rig never gives satisfaction from the very first day it is put in service, and its cost is very little less than that of a good rig. It takes practically the same number of columns, beams, bracing, roof trusses, etc., for a light structure as for a heavy one and a comparatively small amount of additional material enables the designer to obtain the benefit of much larger and much stiffer sections. It is an adage among engineers that a structure which is too heavy in all its parts never gives any trouble except through a slightly increased interest charge on plant and this is therefore not a serious fault if the extra material is kept within reasonable bounds.

The service strains developed in a head-frame or tipple frame are of such character as to render their exact determination difficult, arising as they do from a combination of static and dynamic loads. A good instance of this sort is where the throttle of a first motion hoisting engine is pulled wide open at the beginning of the lift, in which case the strain in the hoist rope while the load is being started is often more than twice the static weight of cage, mine car and load. This strain must be transferred from the head sheave through the different members of the head-frame to the foundation, and the designer who fails to take account of this extra load will not get a stiff structure. Another thing which should not be neglected is that the horizontal component of the strain in the portion of the hoist rope leading from

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the head sheave to the winding drum, varies from its maximum to almost nothing every time a load is hoisted rapidly and dropped upon the cage-keeps at the top. This strain also alternates from side to side of the head-frame with each lift and sets up a combination of racking and twisting strains which must be taken into account if a stiff and durable structure is desired. In attempting to provide for these strains the writer has found it advisable to do away altogether with adjustable rods in the bracing and use stiff members throughout with solid riveted connections. This avoids entirely the necessity for continually screwing up sleeve nuts or turn buckles and any engineer who has had experience in the adjustment of bridges will hail with delight any device which will relieve him from the horrors which may be perpetrated with a monkey-wrench in unskilled hands.

Some of the first steel head-frames turned out badly because the arrangement of the supports for the head sheave bearings were copied from the older wooden type in which the tops of the columns were subjected to transverse strains in addition to their legitimate work. In consequence of this the column heads deflected every time a lift was made and threw the bearings out of level, thereby causing them to cut and give trouble generally. In endeavoring to correct this feature the writer has devised an entirely different arrangement of head sheave supports in which each member has its own legitimate work to perform and is proportioned for the load transmitted as nearly as this can be determined.

A word as to the proper inclination of the hoist rope between the head sheave and winding drum may not be out of place, as in case the angle is too steep there is considerable force acting to lift the winding engine vertically off its bed, and if too flat, the racking tendency on the head-frame is equally destructive. The best results appear to be obtained by using inclinations varying between thirty-five and fifty degrees with the horizon.

In taking up the problem of strains in the tipple frame we find that in this also the horizontal strains need to be provided against very carefully. These arise from suddenly stopping on the tipple horns a load of from two to four tons moving at a speed of one to five feet per second. Probably the best plan for handling this is to provide a heavy floor on the level of the dumps and firmly attached to them, the proportionately greater mass of which first receives the shock and lengthens the period of time of transference into the frame-work and thence to the foundations. In order to provide space for the passage of cars under the tipple, the columns must be left unsupported in the direction of the greatest strain for a height of eight to ten feet from the bottom. They are therefore subjected to transverse strains and must be proportioned accordingly. The writer is free to admit that this is largely a matter of judgment and the proper proportions can only be arrived at by experience. This difficulty can in some cases be obviated by attaching the tipple to the head-frame, which latter should always possess a complete system of longitudinal bracing clear to the bottom. In some other cases a panel containing complete bracing can be placed in the rear of the span over the tracks, but for the most part this latter plan is more expensive than to enlarge the main columns and beams.

Simplicity of design both in main members and connections should always be aimed at in a tipple frame, so as to render easy any changes in screen rig which the varying demands of the trade may require.

The tipple house should consist of a steel frame-work and covering throughout, no wood being allowed except in doors, windows, partitions and floors. Wood should never be used in such a manner that the stability of the structure would be impaired by burning it entirely. Absolutely fire-proof construction is not an economical possibility at present, but the danger from fire can be greatly reduced by proper designing.

The roof and siding should be of heavy corrugated iron, riveted fast by means of metal clips to steel purlins and side girts. It is the poorest sort of economy to use a light weight sheet in the covering and the writer would recommend that nothing lighter should ever be used than No. 20 for siding and No. 18 for roofing. For structures intended to last in one place for twenty or thirty years heavier sheets than the above can be used to advantage, as the extra expense is mainly in the added weight of material.

Another thing which should be looked out for where possible, is the introduction of a fire insulating space between tipple and head frame, tipple and shaft opening, or tipple and slope mouth. This space should be at least ten or fifteen feet wide and across it no continuous line of inflammable material should be allowed to exist; not even those two streaks of oil which seem to follow wherever a mine rail is laid.

The use of screens, chutes, hoppers and pans made entirely of metal has become so nearly universal that it is hardly necessary to say anything in their favor. Some makers of this class of equipment have, in their efforts to cheapen it, used material which was altogether too light and scattered their rivets so far apart that they were hardly on speaking terms with each other. This policy is certain to result in a rig which is a rattle trap at first and a wreck before it has had a chance to get old. The dump plate at the head of the screen should be from five-sixteenths to three-eights of an inch thick so as not to be dented by the fall of the coal. All other bottom plates over which the main body of the coal runs should be from one-fourth to five-sixteenths of an inch thick. The sides of main screens and chutes may be from one-sixteenth to one-eighth of an inch thinner than the bottoms as they do not receive the scour of the coal to the same extent. The bottoms and sides should be joined by angles of a thickness equal to the thickest plate and with flanges wide enough to take one-half or five-eights inch rivets driven hot. Where necessary the top edges should be stiffened by similar angles.

The pitch of rivets should not ordinarily be more than six inches, and in very thin plates less than this. For the nut and slack chutes three-sixteenths and one-eighth inch plate may be used as these handle only a small percentage of the coal and are therefore less subject to wear.

There are but few cases where the engineer in charge of a new opening will find it difficult to provide plenty of height from dump to railroad tracks, and it is to be regretted that so many mistakes are made on this point. The height depends on the number and kind of separations that are to be made and the screen plan should be carefully worked out before the general plan of opening is finally decided on. A failure to do this has often resulted in a fixed charge for elevating, etc., which in view of the narrow profits of mining should always be avoided where possible. For a modern rig making three separations, viz.: lump, nut and slack, it is safe to assume that this height should never be less than thirty feet.

Many of the older rigs, having a height of twenty-six and twenty-eight feet and which were all right in their day, are now giving a great deal of trouble because their discharge chutes will hardly clear the tops of the new gondolas, and trimming the coal to a neat ridge is not to be thought of.

Great latitude is required of a rig which is to load neatly and with minimum breakage all cars which may come to it at the present time. A table of extremes in dimensions of cars is approximately as follows:

Floor to rail: Three feet eight inches to four feet three inches.

Top to rail: Six feet six inches to eight feet six inches.

Extreme width: Nine feet three inches to ten feet six inches.

Length over all: Twenty feet to thirty-six feet.

Sorting these cars so as to give an hour's run on a similar kind is not to be thought of and the rig must pounce on high and low alike without so much as letting out a rod or taking up a chain.

It is not an easy matter to give an idea of the cost of metal as compared with wood, for the reason that when the purchaser has made up his mind to use metal, he demands a better rig in every way than he could possibly get in wood. Taking this into account, the advance over the price of wood will probably average fifty per cent.

Among the advantages which a properly designed metal rig has over a wooden one are these:

Comparative safety from fire. The bill for pumping alone in some mines while replacing a burned-out tipple would more than pay the difference, to say nothing of the other losses.

Durability. A metal rig which is heavy enough for its work is much more durable on account of its greater elasticity, which enables it to sustain shocks without permanent deformation.

In consequence of the above, a good metal rig should last twenty or thirty years, even if taken down and put up in different locations; while a wooden rig which has seen six or seven years' service is not worth taking down, much less putting up again.

In conclusion it may be said that as the tipple is the focus toward which all the other operations of the mine are directed and through which all the product must pass, the progressive operator will see to it that it is of the best and most durable both as to material and design. (Applause.)

THE CHAIR: You have heard Mr. Lewis' valuable paper. Has anyone anything to say on the subject? I don't know whether any of us are able to discuss this paper very thoroughly or not.

PROFESSOR RAY: I hardly agree with the gentleman in what he has said in his paper. I believe in steel construction for tipples—rigs, he calls them. I believe in their being of slow-burning construction, as nearly fire proof as they can be made, and that is one of the reasons why steel tipples should be adopted. I believe he said the cost would reach about fifty per cent. more than wood, and Ohio has hardly reached that point yet. As long as there is timber on the coal lands I suppose there will be wooden framed tipples built. When it gets so scarce that they will have to bring it from a distance, then metal frames will probably be adopted. The point of preventing dangerous fires is one of the principle reasons why they should be adopted.

SECRETARY HASELTINE: Mr. Lewis prepared that paper at my earnest solicitation, as I knew he was probably one of the most advanced men in our acquaintance on the question of steel tipples—as we call them in Ohio—and the fact that many of our operators are considering the question I know they will read a paper prepared by an engineer in that business with interest. I have on my desk now many inquiries from operators in the State inquiring as to the propriety of building steel tipples. One I call to mind now raises the question as to the discretionary clause in the mining law, as to whether it could be applied if thought proper to permit the operator to put the boiler nearer the hoisting house if built of steel and iron. The law now provides sixty feet. There have been quite a number of hoisting rigs burned in the last seven or eight years, and the question of safety is quite a serious matter, especially in the deep shafts now being opened in some portions of the State where the necessary time that must elapse from the time the shaft is sunk until the mine is developed sufficiently to enable a second opening to be put down, allowing a means of escape, would be several months. If they would have steel and iron hoisting house, the danger of the miners being cut off by fire would be very much less than under the present conditions.

Colonel Rend, in speaking of steel tipples, said to me some weeks ago that he had just completed one at one of his mines in Pennsylvania, and he made the astonishing statement that it cost him less dollars to put up and equip his steel tipple than it did one of wood. He told me the exact cost of it, which I cannot now call to mind, but he said he never built a wooden tipple for so little money in his life, and he said he never would build another one of wood. But the fact that it cost less than wood was to me an astonishing statement, for I had labored under the impression that the steel cost perhaps double that of wood. It is a question that is meeting with a great deal of consideration now on account of the low price of iron and steel, and I think it should, especially in the portions of the State where they are going to a greater depth than usual.

PROFESSOR RAY: I don't think the Institute should be misled by Colonel Rend's statement. We know his methods of working, and I think his comparison was between the tipple he built at McDonald—one he moved from Straitsville.

MR. LEWIS: You remember in my paper I said a man generally wants a better rig when he gets his mind made up to build in metal than in wood, and on account of that tendency of operators, it takes generally fifty per cent. more to build such a rig as they want in metal than it would to build one in wood. Colonel Rend's tipple is very simple. It has no other complications than in a wood tipple, and no doubt his statement is correct, that he built it as cheap as he could in wood.

PROFESSOR RAY: I know he moved a tipple from down at Straitsville to McDonald. He took that old tipple and paid the freight on it and moved it to McDonald and hired men to work it over and put it up, and it cost him more than to go into the woods and get the timber out for it, and if he compares with that tipple, I have no doubt of it. I think that steel tipples ought to be used for reasons of safety, but I don't put very much value in that statement of comparison.

MR. T. E. HUGHES: I would like to ask whether the steel tipple would cause any results in the way of explosions by lightning? It occurs to me that if you put a steel tipple over an opening, the electrical current would follow the rails down to the opening. Perhaps if you put a heavy copper conductor on, it would relieve it. If not, would that not be a serious matter to be overcome in steel tipples? If so, how is it to be overcome?

MR. LEWIS: I have yet the first case to hear from where a metal rig has been struck by lightning; and with particular reference to the head frame, all the shafts are wet and the current would find a very large area of what the electricians call ground before it would get down. In addition to that the head frame makes a great big lightning rod, because the large mass of iron or steel forms a multiplicity of conductors, spreading the current, and all lead directly to what electricians call good ground. In the anthracite regions an exception did occur. Lightning struck the head shaft and followed the rails down to the bottom and caused an explosion; but that is a rare case.

MR. HUGHES: It is true you have a superficial area far greater than that furnished by a lightning rod, but it occurs to me that this will only arrest the course of the lightning temporarily. The farther it would go into the shaft, the farther it would get into the moisture, and the excessive charge of lightning would not disseminate itself until it reaches the bottom of the mine. I was merely inquiring if lightning would follow an ordinary shaft down from a steel tipple. Of course in wooden tipples there would not be that danger.

SECRETARY HASELTINE: It is a very rare occurrence for a rig to be struck by lightning in Ohio. I never knew but one struck and burned and that occurred last summer. But it occurs to me that the lightning would strike so much surface of iron that it would find a ground before it went down the shaft. We never hear of a blast furnace or rolling mill struck with lightning. The probability is that the electricity passes down in a silent current all the time during an electric storm. And so with a steel rig, there is so much surface exposed that the electricity would pass off in large sheets and there would not be a bolt that would cause an explosion. And, too, we have so few mines that generate gas and such good circulation of air in the mines, that we do not find gas enough at the bottom to cause an explosion.

THE CHAIR: Are there any other comments on this paper? I am interested in learning about this subject. I have seen the tipples advertised and am interested in hearing more about them. I think my company is now putting one in. If there is no further discussion desired on this subject, we will pass on.

On motion the Institute voted its thanks to Mr. Lewis for his valuable paper.

THE CHAIR: Next on the program is a paper by Thos. H. Love, Leesville, Ohio, on Practical Mining.