flesh is death, and the end of all boilers is explosion. An old writer quaintly remarks that, "If a man lives long enough he will certainly die." In the same way, if a boiler is worked long enough it will explode, in spite of all the safety appliances which ever were or ever will be invented. At best these can only provide for the occurrence of certain phenomena which, without this provision, would cause an explosion; but they certainly cannot provide for the occurrence of *all* the phenomena which produce explosions. Until a safety-valve or a fusable plug, is invented which shall stop a leak or put on a patch, or arrest the progress of corrosion, neither one nor the other can prove its title to be esteemed as an infallible specific. The only certain preventive is careful, properly organized and thorough inspections; and the reports of our steam-boiler societies prove its efficacy daily.

"Experience goes to prove that fully as many explosions occur while the engine is in motion, or while the boiler is under steam and the engine at rest, as at any other time. It is almost impossible to trace any connection between the withdrawal of a portion of steam from a boiler and the subsequent explosion of the latter. Could it be proved that the gage either rose or fell perceptibly, the case might be different; but the hand seldom moves, instantaneously at least. The only remarkable phenomenon is, the sudden rise of the water in the glass gage; and this rise from its character would seem to denote a dilation of the whole body of fluid, not a mere foaming or priming, for the gage shows a rise of "solid water" invariably, and not foam, when the boiler is properly full. It is not likely that either of these explosions will ever be found to present any unusual phenomena; but the lesson which they convey is not the less instructive. Inspection, and careful inspection alone, can secure safety, and the sooner steam engine proprietors become convinced of the truth of this proposition, the better for the entire community."

FLY WHEELS.

The fly wheel is the most elegant mechanical device in existence. It answers its purpose when properly designed, and put to work as it should be, with almost absolute perfection. It is very inexpensive, never wears out, causes very little friction, wastes an insignificant amount of power, takes up, in one sense, but little room, is equally applicable to reciprocating, rotatory machinery, under a host of varying circumstances and conditions, and, in short, fulfils every demand which can be made on its powers with an ease and certainty which entitle it to rank in the foremost place as an example of the accurate adaptation of certain means to a desired end. By whom it was invented is a question which has never yet been satisfactorily answered, and in all probability never will be. For the first idea of its application to the steam engine the world is indebted to Fitzgerald, an Irish professor, who proposed, in 1757, that it should form part of Papin's engine, working with rack-headed piston rods, gearing alternately into a pinion on the main shaft. Up to that time the crank had never been fitted to the steam engine. It has been urged that the fly wheel was practically unknown previously to this date, but there can be no doubt that such a statement involves a gross error. Old spinning wheels worked with a treadle and crank are still in existence, constructed much more than one hundred years ago. The fly wheel is one of those things which never were invented. Its application to machinery is a growth, not a creation, and the history of that growth goes back so far that it is totally indistinct, lost, and shrouded, in the mists of the past. No interest was attached to it until it became an all but indispensable adjunct to the steam engine, and therefore no records exist calculated to clear up that which is obscure. If there were any pecuniary advantages to be derived from tracing a lineal descent from its inventor to some individual of the present generation, we should hear a great deal more of the matter. The world always does hear much in such cases, but as the fly wheel in its simple form never was patented, and as its use is open to all mankind, it is seldom indeed that the question is asked, From whence did this thing come? and with this state of affairs we may rest and be thankful.

The duties performed by a fly wheel are very simple. Within its periphery,—speaking in general terms, which neglect the effect produced by the arms and centre bars—is stored up at particular periods a certain amount of power, absorbed in the impartation to the mass of a slightly increased velocity of rotation; and this power, by a law of nature as inexplicable and mysterious—and let us add, as simple withal—as the action of gravity, must there remain stored up even to the end of time, unless the motion of the wheel be reduced, or stopped altogether Further, all this power will be returned in fact to the machine, when the speed of the wheel is reduced exactly that amount which it was previously increased in order that the power thus returned might be taken up. As a result the fly wheel cannot produce perfectly regular motion. It can only prevent sudden and violent irregularities of motion. At the moment when the piston arrives at, say, the middle of its stroke, the strain on the crank pin, and the power of this last on the wheel, will be at or near a maximum; the velocity of the wheel then becomes slightly accelerated. As the crank arrives at the dead points its effect is lost; then the wheel gives out its store of power, but in so doing, its speed must fall off to exactly the rate which it possessed before it was accelerated: thus during every revolution of a single cylinder engine, there are two periods of retardation and two periods of acceleration, and the mechanical value of these periods will depend on the speed and weight of the wheel; and thus, although the irregularity can never be wholly eliminated in such engines, it can always be brought within reasonable limits. The maximum velocity occurs—when the pressure on the piston, or rather on the crank pin, is pretty uniform,—when the crank is at an angle of about 140 degrees; and the minimum when it is at about 20 degrees from the dead point; and the duty of the fly wheel is involved in rendering the difference between these two velocities as small as may be deemed necessary. We have no desire to burden our pages with abstruse formula, but the following rule, given by Professor Pole for finding the weight in cwts. of a fly wheel, will be found generally useful, and is certainly not abstruse:—