THE POWER REQUIRED TO OPERATE THE SHIP RAILWAY.

We publish elsewhere a letter from Mr. C. K. Needham, civil engineer, expressing a doubt as to the possibility of locomotives starting so heavy a mass as a ship on a single car.

He says: "When a locomotive begins to pull a heavy train, it is necessary that the connections between the cars should have some slack or spring. Otherwise the most powerful locomotive could not overcome the quiescent inertia of the train."

This is an error; he doubtless meant to say that a locomotive which is sufficiently powerful to keep a train in motion after it is started is not always powerful enough to start the entire train, unless some slack exist in the couplings between the cars. This is true. The problem is really a very simple one; numberless experiments have been made to determine the amount of frictional resistance to be overcome in starting trains from a state of rest, and the amount of this resistance when the same train is in motion. The friction in each case is of a double character—the rolling friction, created between the periphery of the wheels and the rails, and the sliding friction, created between the journals and the boxes in which they revolve. This latter is generally called axle friction. Rolling friction results from the fact that all materials used by engineers are more or less elastic. The hardest steel is no exception to this rule. When a steel ball is dropped from the height of a few feet upon a flat steel plate, it rebounds, and is thrown upward to about half the height from which it fell; this could not occur if the two surfaces of steel were not elastic. The plate is indented, temporarily, by the momentum of the sphere, and the shape of the sphere is momentarily distorted by the resistance of the plate. The rebound is the result of the instantaneous recovery of their respective forms.

When a wheel is at rest upon a rail, the rail is depressed beneath it, and the circular form of the wheel is also changed in proportion to the amount of the weight which presses the two surfaces together, the change of the form of each being analogous to that which would occur if both were made of India rubber. The force necessary to roll the wheel, when the rail is perfectly level, is that which is required to depress the rail as the wheel advances, and to cause the wheel to alter its form as it rolls forward on the rail; this resistance is known as rolling friction, and it will be reduced in proportion to the hardness of the surfaces in contact. The force necessary to start a wheel from a state of rest will be greater than that required to keep it rolling after it has started, because the element of time affects the problem. If the wheel is rolled rapidly over the rail, the two surfaces will not have the time necessary to accomplish the full alteration of their forms before the pressure has ceased at the point of contact. Hence the rolling friction will be decreased if the velocity be increased. The phenomena of sliding friction are so well known that it is not necessary to allude to them.

The results of the many experiments that have been made to test the amount of axle and rolling friction in railroad trains when at rest and in motion vary very much, because of the difference in the lubricants used, the degree of accuracy with which the wheels and axles are turned, the fit of the boxes, the size of the journals, the various weights carried on them, and the accuracy and hardness of the rails and wheels. The greatest resistance to starting the train, recorded by these experiments, is, we believe, about twenty pounds horizontal strain to each ton of weight of the cars. When in motion, this resistance falls to about five pounds per ton. If we take a train of ten cars, assuming each to weigh forty tons, the resistance to the starting of each car will be equal to eight hundred pounds, and for the ten cars eight thousand pounds. The resistance, when in motion, would be reduced to one-quarter of this, or to two thousand pounds, hence a locomotive whose maximum tractive power would be two thousand pounds would be able to keep such a train of cars in motion, on a level road, but would not be able to start the train. Starting one car after the other, supposing that slack enough existed in the connections, it would only be able to start seven cars. Six being in motion would absorb twelve hundred pounds, while the seventh, being at rest, would require the remaining eight hundred pounds. To start the ten cars, the locomotive would require to have a tractive power of twenty-six hundred pounds, because, after nine are in motion, the resistance of each falls to two hundred pounds, or eighteen hundred pounds for the nine, while the resistance of the tenth, which is at rest, would be eight hundred pounds. The starting of the entire train, from a state of rest, if rigidly connected, would therefore require a little more than three times the power necessary to start the train if not rigidly coupled.

In the case of starting a single mass, like a ship, upon a single car, the same principles would apply. If we assume the weight to be six thousand tons, and the resistance to be twenty pounds to the ton, the tractive power necessary to start the car would be one hundred and twenty thousand pounds, while the power necessary to keep it in motion would be about only one-fourth as much.

It is plain, then, that the power required in either case is simpiy a question of area of piston pressure per square inch upon it, and of leverage exerted by the crank and wheel upon the axles. In railroad practice, locomotives invariably have a large surplus of power over that which is necessary to keep the train in motion; and while the locomotives necessary to simply start six ordinary trains weighing one thousand tons each would need an aggregate tractive power of less than forty thousand pounds, those necessary to start six thousand tons in one mass would require a tractive force of one hundred and twenty thousand pounds, or more than three times as much; but after these respective masses were once in motion, the tractive power required by the locomotive of each would be the same, hence the actual cost of hauling the loads or the fuel consumed would be the same for each six thousand tons. It does not follow, however, that the locomotives for the six trains would be limited to a tractive power of forty thousand pounds; on the contrary, a large surplus over that would be required to insure the certainty of starting promptly, for the reason that there are no perfectly level railroads in operation, and wherever grades intervene, additional power is required by the locomotives, to ascend such grades, and this additional power would be no greater in the case of the ship railway than in that of an ordinary railroad. A grade of one foot in a hundred would increase the tractive power required to an amount equaling one per cent of the load, which, for six thousand tons, would be sixty tons, or one hundred and twenty thousand pounds additional to that which would be required to start the ship, or a total of two hundred and forty thousand pounds to start it upward on such a grade.

The engines employed by the ship railway would, no doubt, have four cylinders each, and three locomotives would doubtless be employed to haul a load of six thousand tons. This would be equivalent to twelve cylinders, and, supposing one-half of the cranks actuated by the pistons in those cylinders to be at the dead point, there would still be six pistons in full force.

Let us assume the wheels to be five feet in diameter, and the stroke thirty inches, and cylinders twenty-eight inches bore; we would then have, on six pistons, an aggregate area of three thousand six hundred and ninety square inches, which, with one hundred and twenty-five pounds pressure, would be equal to four hundred and sixty-one thousand two hundred and fifty pounds. Let us suppose that only one-third of this is converted into tractive force through the loss of leverage in the cranks and wheels; we would have one hundred and fifty-three thousand seven hundred and fifty pounds of tractive power to overcome the resistance of one hundred and twenty thousand at starting. On grades of one per cent, three more locomotives would be required to start the load upward, when standing on such grade.

This would insure an abundance of power to start the car, and, after it was started, the steam could be worked expansively, and with greater economy, at an average pressure of thirty or forty pounds to the square inch.

It is, therefore, only necessary for the ship railway to provide somewhat larger cylinders than are ordinarily used on locomotives to insure the surplus pressure necessary to overcome the resistance to starting the cars, while, as we have said before, the consumption of coal during the trip would be no greater than if six trains, weighing one thousand tons each, and composed of ordinary cars, were being hauled over the same line.

The pressure upon the piston at the time of starting is usually equal to that in the boiler, the valve being wide open, while the pressure upon the piston when the train is in motion is much less than the maximum pressure in the boiler.

In the case of the ship railway, it would be found practicable to use the steam more expansively than in ordinary railway practice, and this would tend to greater economy of fuel.

PHOTOGRAPHIC NOTES.

IMPROVED PYRO DEVELOPER FOR LANTERN SLIDES.

The use of ferrous oxalate developer, considerably restrained with bromide of potassium and citric acid, in the development of lantern slides on gelatine plates, has been invariably recommended by manufacturers, for the reason that there was no danger of staining the film, and in consequence greater ease in obtaining clear, crisp pictures; but if the exposure had been too short, and forcing of the developer was rendered necessary by additions of the iron solution, a disagreeable precipitate of the ferrous oxalate would occur over the surface of the film, thereby injuring it.

As pyrogallic acid is now largely employed in the development of negatives, its possible use as a developer for transparencies would add much to the convenience of the amateur, in avoiding the necessity of his having two kinds of chemicals, viz., one for negatives and one for positives.

Recently it has been found that a freshly made pyro solution answers admirably as a developer for lantern slides, and we can recommend the following formula as being reliable:

Saturated solutions of citric acid, chemically pure sulphite of soda, and chemically pure carbonate of soda are first prepared. Then a solution of either bromide of potassium or ammonium in the proportion of 1 ounce of the bromide to 4 ounces of water.

The developer is mixed in the following order:

Water	3 ounces.
Sulphite soda solution	1 ounce.
Citric acid solution	5 minims.
Bromide of potassium solution	10 minims.
Dry pyrogallic acid	8 grains.
Carbonate of soda solution	1 drachm.

This is poured upon the exposed plate or plates (for several may be developed at one time in a tray), and the effect watched. After a minute's soaking, should no image appear, another drachm of the soda solution is added and continued to be added in small amounts until some action occurs.

The picture develops gradually, or in about one-third that required by the oxalate developer; and if a slow brand of plate be used, not a trace of stain or fog can be seen. As soon as the details in the high lights appear well out, which is judged by the surface appearance of the picture on the film, the plate should be removed, washed in changing water for two or three minutes, and then fixed in a fresh hypo bath.

After again washing, it is immersed in a clearing bath for three minutes.

CLEARING SOLUTION.

Saturated solution of alum	20 ounces.
Sulphuric acid	1 drachm.

Then washed in changing water for one hour and allowed to dry.

The peculiarity of this developer is that it imparts to the image, at once, without further toning, a rich, warm, brown color, so desirable for lantern slides. By giving a long exposure with a well restrained developer the best result is obtained. Too short an exposure changes the color to a blacker brown.

For contact printing, an exposure of 10 seconds three feet from a gas or kerosene light is advised. When reducing in the camera by diffused daylight, from 10 to 30 seconds is sufficient. With lamp light diffused by a ground glass, the exposure may range from 45 seconds to 3 or 4 minutes, according to the density of the negative and the size of stop employed in the lens.

While it is safer to use the developer but once, we have found it practical to develop from two to three plates in rapid succession in but one ounce of developer. One of the advantages of this developer over the ferrous oxalate is that it may be strengthened by the addition of the carbonate soda solution without producing any precipitate.

Capt. Abney's Method of coating Paper with Gelatine Emulsions.—From the *Photographic News* we glean the following particulars respecting Captain Abney's process:

The sheet of moist Saxe paper is laid on a glass plate somewhat larger than is necessary, having its edges cemented to the glass with a solution of gelatine and water. The paper is then allowed to dry, and in shrinking becomes as smooth and even as the glass itself. It is then coated with the emulsion the same as an ordinary glass plate, and allowed to set and dry. He states it is just as easy to coat paper as glass. The emulsion used contained about 5 per cent of glycerine, or 50 cubic centimeters of glycerine were added to each liter of emulsion. Owing to the repellent character of the glycerine in the emulsion to the developer, he found it necessary to immerse or draw the paper through a bath of glycerine, composed of one ounce of glycerine to twenty of water, before developing.

To Detect any Yellow Tinge in Lenses.—If lenses are long exposed to the light, the glass sometimes becomes very slightly yellowed, which affects the rapidity of the lens, since it prevents the passage of the most active rays. To detect the yellow hue—says the *Photo. News*—lay the lens upon a piece of paper of a very pale blue tinge—such as blue foolscap—when even a very slight degree of yellowness will be easily perceived.

William H. Guild.

The death of William H. Guild, of the firm of Guild & Garrison, steam pump manufacturers, of Brooklyn, which occurred on November 11, removes from the mechanical world one who had greatly endeared himself to his colaborers and a large circle of friends for his ability as a mechanician, uprightness as a man, and cordial disposition as a friend. He was born in Connecticut, and had reached the age of fifty-three years. At the age of sixteen he located in Brooklyn, and learned the trade of machinist as connected with the manufacture of steam pumps. His father was one of the original firm of Guild & Garrison, and William H. succeeded to his place at the time of his death.