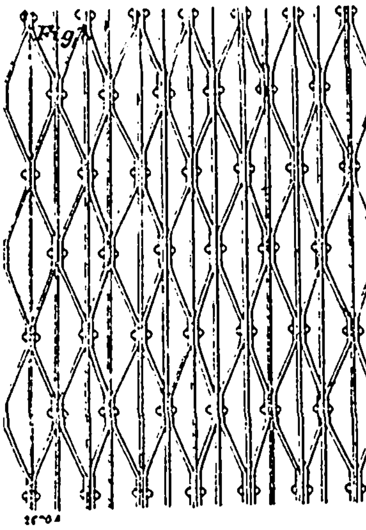
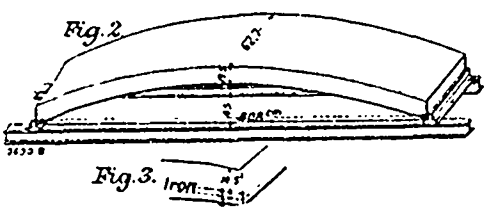
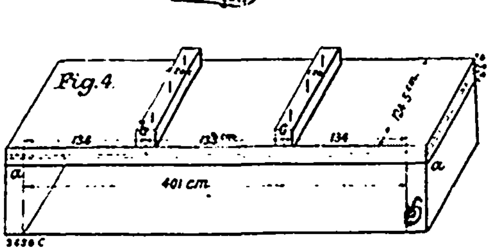
made of hoop iron from .06 in. to .1 in thick, and from 1 in. to 1½ in. wide. The report states that the presence of this iron-work almost quadrupled the strength of the concrete. The first test was made on an arch (Fig. 2) of 13 ft. 3 in. span, 17.72 in. rise, and 24.7 in. wide by 7.07 in. thick. The concrete used consisted of 1 part of cement, 3½ parts of sand, and 9 parts of river gravel. Some of the pebbles used were 2 in. to 2¾ in. in diameter. The hoop iron was uniformly .06 in. thick







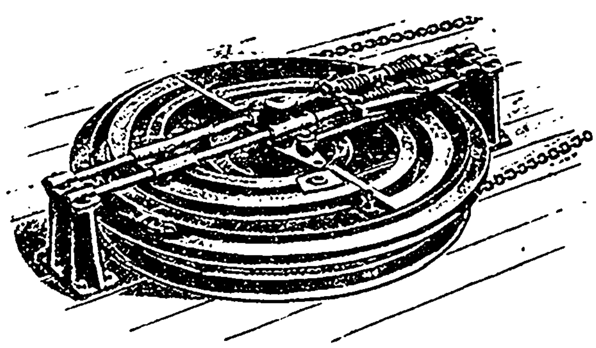
by 1.18 in. wide. It was imbedded in the concrete slab 8 in. from the bottom surface, as indicated in Fig. 3. At the time of the test the slab was six months old. It was mounted on iron angles and rails, as shown, and loaded with rails. These rails were 18 ft. long, and projected, therefore, several feet on each side of the arch. Each rail length weighed about 485 lb., and these were loaded direct on to the plate, commencing on the left-hand side, and gradually covering the arch up to the right-hand abutment. The first layer consisted of 30 such rail lengths, the total weight being about 6.65 tons. A second layer of 34 rails was then added, starting at the right-hand side, which, when completed, gave a pretty uniformly distributed load of about 15 tons. A third layer was then commenced, but when the fourteenth rail was put on, *i.e.*, before the middle of the arch had been reached, the slab showed signs of cracking. Adding a fifteenth rail caused this crack to spread, and at the same time the abutments showed signs of yielding. When the eighteenth of the third layer was added the whole arch collapsed, apparently from crushing at the abutments. An examination made afterwards showed that the slab was cracked all over.

The second test was made on a flat plate 13 ft. 3 in. long by 4 ft. 1 in. wide by 6.3 in. thick, which was supported on two brick walls, as indicated on Fig. 4. The concrete was the same as in the previous case, but the hoop iron was wider, viz., 1.58 in., and its thickness varied in different parts from .06 in. to .1 in. It was imbedded 1.6 in. from the bottom of the plate. Two balks of timber 7.9 in. square were laid across the plate as shown in the figure; on this the rails were laid. This was not, however, done quite uniformly, so that the left-hand balk actually took about .6 of the load in place of one-half. The first layer consisted of 11 rails, and weighed 2.42 tons. The central deflection was found to be .28 in. The second layer consisted of 10 rails, and under it the deflection was increased to .73 in., the total load being 4.62 tons. Four more rails increased the deflection to 1.05 in., and the load to 5.5 tons. A fifth rail, added after waiting some time, at first made the total deflection 1.45 in., but later on the slab broke. The plate was most cracked in the neighborhood of the balk taking most of the load.

AUTOMATIC RUDDER LOCKING APPARATUS.

The shocks and noise occasioned by the tiller chains is a matter of much inconvenience and annoyance experienced by nearly everyone who travels by sea. The annoyance is practically constant during the whole time the vessel is under way, and of a very monotonous and irritating nature. Any device that will minimize the shocks produced by the surging of the sea, that occasions the noise, will most certainly meet with the best approval and appreciation of the travelling public.

The *Marine Engineer*, of London, illustrates an automatic locking apparatus for the rudder, for which are claimed the following advantages: First, the helm is automatically locked on the rudder cross-head direct by the action of the device, preventing any shock coming upon the steering chains or other communicating means, the locking being done by the rudder itself, when the surge and shocks of the sea take place. Secondly, the revolutions of the steam steering apparatus or other motive power increase as the helm goes over, whereby increased power is obtained. Third, by a very simple adjustment, a quicker motion or purchase can be given to the helm for narrow waters, where quick manœuvring is desired. Fourth, by the fact of all surges being taken direct on the rubber-head, all the steering connecting are thereby relieved, the steering will be affected more easily, and chance of breakage minimized.



Referring to the illustration, it will be noticed that the rudder-head carries a complete quadrant wheel, loosely journalled thereon. Within the quadrant wheel two pairs of circular racer guides are arranged, the paths of which are eccentric to the axis of the rudder, and disposed opposite to one another. Within these racer guides blocks are adapted to slide, which are each pivotably connected by pins to a sliding cross-head mounted on two cylindrical guides, one cross-head being arranged on each side of the centre. These cross-heads are connected by connecting rods to the ends of