previous years, as well as other data, including peculiarities in modes of manufacture, which may be useful for comparison with the methods pursued and the results obtained at other factories. There can be no doubt that these efforts must sooner or later result in the formation of a dairy science, and in the establishment of sound theories of dairy management.

But the functions of the American Dairymen's Association are not confined to observation and experiment at home. Already the inquiries of its officers have enabled its members to improve their cheese-making practice by adopting some features of our Cheddar system; and in the last volume of the Report of the Association is an able paper by Prof. Caldwell,* showing some features common to the numerous cheese-making processes followed in Holland, Switzerland, France, and Italy. One of the most interesting points brought out is the intimate connection that exists between the ripening of cheese and the development and growth of *Micrococcus* and other forms of mould. As a matter of commerce it is important to the farmer to ripen his cheese as soon as possible. This is done in various ways, all having for their object the introduction of large numbers of germs of the appropriate fungus. The ripening of Stracchino cheese is thus induced by the introduction of layers of old curd; that of Roquefort by an admixture of mouldy bread, containing germs of *Penicillium*, and that of Brie by packing the thin cheeses between layers of musty hay. Another observation of interest is, that the presence of free ammonia in the curing-room hastens the ripening of the cheese, a fact which may have some bearing on the well-known property of American cheese (which is always packed in boxes) to ripen more rapidly than English makes.

These evidences of a process of scientific investigation induce us, therefore, to regard the factories, or associated dairies, as they are termed, as possessing a scientific value, both as educational establishments and as laboratories. But, it may be asked, why is this not true also of the farm-dairy? Our answer is, that while the manager of a factory makes cheese-making his sole business, his success in which depends entirely on his skill and knowledge, the English dairy-farmer has little or nothing to do with cheese-making, but occupies himself with the management of his farm. With the production of the milk his supervision ceases, and the manufacturing process is either carried on by his wife, who has household cares to occupy her time and thoughts, or by a dairymaid, who has no interest in the matter, and who knows that her services are at a premium.

Thus, with the exception of the additions to our knowledge of the *rationale* of cheese-making, for which we are chiefly indebted to Dr. Voelcker's chemical researches,† the manufacture of dairy products in England can hardly be said to have advanced during the last half century, while it has made enormous strides in America during the last ten years. Let us hope that the establishment of cheese-factories in England, commenced last year at the risk of some liberal-minded Derbyshire landlords,‡ may also be the dawn of an English era of progress in this most important agricultural industry.

* Sixth Annual Report, Syracuse, N.Y., 1871, p. 25.
† Vide Journ. Royal Agric. Soc., vol. xxii. p. 29, and vol. xxiii. p. 170.
‡ Ibid, 2nd series, vol. xii. p. 42.

HYDRAULIC BUFFER FOR CHECKING THE RECOIL OF HEAVY GUNS

THE ingenious instrument, the name of which stands at the head of this paper, deserves some notice, not only on account of its utility for its purpose, but as an interesting method of meeting and overcoming those violent efforts of nature to which she is provoked by explosion. In the recoil of a heavy gun, we have an example of the greatest force which man attempts to control. The inventions of Captain Moncrieff, which no long ago formed the subject of an article, seek to utilise this force; other gun carriages lead it to expend itself as harmlessly as possible.

The Hydraulic Buffer accomplishes this latter object in a manner very ingenious, and affording some interesting illustrations of Nature's laws; it also possesses several advantages over other methods which have been and are still used. For it the public service is indebted to Colonel Clerk, R.A., F.R.S., Superintendent of the Royal Carriage Department in Woolwich Arsenal. Before the introduction of the Hydraulic Buffer into the English service, and in those cases where it is not yet applied, the method employed to overcome the recoil was the friction of iron plates. To the bottom of the gun-carriage several plates are fixed, which pass between long plates placed along the middle of the slide or platform on which the carriage runs; and the friction of their surfaces in contact overcomes the force of the recoil, and brings the gun and carriage to a standstill. The amount of the friction can be regulated by the compression given to these plates, and requires to be altered for the various charges used. The compression must be taken off to allow the gun to be run forward to the firing position, and must be again set up to meet the recoil.

The Hydraulic Buffer, on the other hand, is always ready for use, and never needs any adjustment. This is one of its advantages, and one which is of special importance in the heat and excitement of action. It consists of a cylinder (A B in figure) placed in the platform, and lying along its length. In the cylinder is a piston pierced with four holes, and the extremity of the piston-rod is attached to the carriage. When the gun and carriage are run out for firing, the piston is moved to the lower end of the cylinder (A), which is filled with water, except a small air-space exceeding slightly the cubic content of the piston-rod, so as to allow for the displacement of the water when the piston is driven to the other end of the cylinder. When the gun is fired, and with its carriage begins to recoil, the piston is driven back into the cylinder. The first effect of this is to compress the air in the cylinder very violently, then the water begins to run through the four holes in the piston, this motion soon attains a very great velocity, and in imparting this to the water, the force of the recoil is soon exhausted. It is spent in transferring the water with very great rapidity through these orifices from one side of the piston to the other.

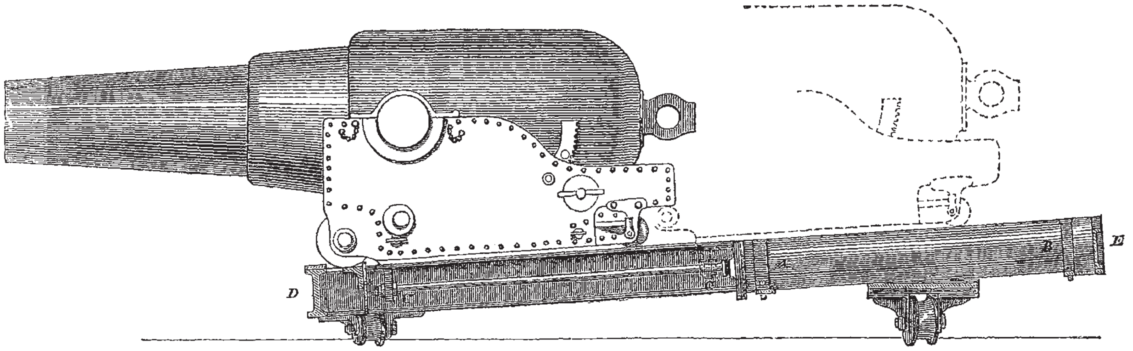
This rapidity depends on the ratio of the area of the piston to the area of the four holes in it. A very small diminution in the area of these orifices would cause the recoil to be checked very much sooner; a correspondingly slight increase would allow the piston to strike with violence against the end of the cylinder. It was found in an experiment with a 20-pounder gun, that when the holes were 0·562 of an inch in diameter, the recoil extended the whole length of the cylinder, 2ft. 9in., and struck violently the end of it; when a piston was used with holes 0·437 in. in diameter, the recoil was only 1ft. 11in., and ended quietly, the same charge being used. In another experiment with a 12-pounder gun in a boat carriage the holes in the piston were five-eighths of an inch in diameter, the recoil was 2ft. 2in.; when the diameter of the holes was increased by one-sixteenth of an inch the recoil was 3ft. 2in.* The proper ratio of the area of the holes to the area of the piston is evidently that which will allow the recoil to expend its force in nearly, but not quite, the whole length of the cylinder. When once this ratio is fixed, it is very remarkable that the amount of the charge, or the slope at which the platform is placed, whether up or down or

* The reason of this is evident from a little consideration: first, every addition to the area of the holes diminishes the area of the piston, which acts on the water; secondly the difference of the work done by the recoil is proportional to the difference of the *squares of the velocities* given to the water in passing through the orifices in the two cases.

horizontal, makes comparatively little difference in the length of the recoil. With a 12-ton (300 pounder) gun a service charge of 30 lbs. of powder gave a recoil of 4 ft. 5 in.; with a battering charge of 43 lbs. the recoil increased only to 5 ft. 1 in.. If the charge is heavy, or if the slope favours the recoil, the carriage will not go much further back than if these conditions are reversed. But it will do so more rapidly. The space travelled over is not much greater with the violent recoil, but it is done in a shorter time. It is also worthy of notice that quick burning powder, such as the rifled large grain, does not give so long a recoil as the slow burning ones, such as the pebble and pellet powders, although it acts much more violently on the gun; the reason is that the recoil is more rapid. Few machines give so striking an illustration of how important an element is time in work to be done, and how much force is to be increased if anything is done more rapidly. The strength of one man is quite sufficient to push in or pull forward the piston of the Hydraulic Buffer, because he does it quietly, "takes his time to do it." The force of a 25-ton gun, recoiling from the discharge of 70 lbs. of powder, and a 600 lb. shot exhausted itself in doing the same, because it does it so quickly.

In fact, the ease with which the hydraulic buffer permits slow motion is one of its disadvantages, and prevents its application to sea service carriages, as it would not keep the carriages from moving as the ship rolled. A modification to obviate this difficulty has been proposed. It consists of a solid piston (without holes), and the back and front ends of the cylinder are connected by a pipe through which the water is driven by the recoil. The motion of the water can be stopped altogether by the stop-cock till the gun is fired, and the area of the orifice through which the water is to pass can also be regulated by it.

The resistance of the water, and consequently the pressure on the cylinder from the recoil, is not uniform. It becomes greatest at the moment when the air receives its maximum compression, before the water attains its highest velocity in passing through the holes in the piston. At this point the force of the recoil is felt as a severe strain upon the cylinder and the platform which holds it. This destructive action of the recoil of heavy guns not only upon platforms, pivots, and racers, but also upon the foundations on which they rest, is one of the great difficulties with which modern military engineering has to grapple. To remedy this disadvantage by causing the recoil to meet with a gradually increasing resistance,



A B cylinder; C end of piston-rod attached to carriage; C′ end of piston-rod after recoil; D E slide or platform. The dotted lines show the position of the carriage and gun after recoil.

so that its force may be felt as a continuous pressure, and not at any point as a shock or blow, the following very ingenious arrangement was proposed by Mr. H. Butter, Chief Constructor in the Royal Carriage Department. It consists in placing along the length of the cylinder and through the holes in the piston four tapering rods, the largest extremities of them being at the rear end of the cylinder, and being of such a size as there to fill completely the piston holes. These orifices and also the whole cylinder must be larger than where the rods are not employed. The effect in this case is that, as the area for the water to flow through the piston is continually diminishing as the holes get further along the rods, the force of the recoil has to impart a continually increasing velocity to the water, and is at no point felt as a shock or blow. The resistance, slight at first, gradually increases throughout the recoil, and so exhausts its force not at any one point, but throughout the whole of its course.

It has been suggested, and it is a consummation most devoutly to be wished, that the Hydraulic Buffer might be applied to railway trains so as to take away the destructive effects of a collision. A train of carriages separated by Hydraulic Buffers would, if suddenly stopped at a high speed, simply close up, the piston being driven in, and the force of the collision would exhaust itself in the motion given to the water in the cylinders. Some practical difficulties stand in the use of this application of the invention; principally, that the length of the piston rods would inconveniently increase the length of the train. But there are none which might not be overcome by a little ingenuity; and the great importance of the object to be gained makes the neglect of any promising means to attain it highly culpable. However, slowness in taking up new ideas (especially if they do not immediately add to dividends), is not altogether a peculiarity of Government departments.

A very interesting pamphlet on this subject has been published by Colonel Clerk, in which Mr. Butter shows the work done in the Hydraulic Buffer, by comparing it with the moment of a similar weight of water falling through such a height as to give it the same velocity as that with which it passes through the holes in the piston. By this ingenious comparison he ascertained that a locomotive engine, weighing 50 tons, and moving at the rate of 30 miles an hour, would be brought to rest in the space of six feet by two Hydraulic Buffers of 12in. diameter. "There are," Colonel Clerk remarks, "two important problems to be worked out by the railway authorities:—(1) to have no railway collisions; (2) if they must sometimes occur, to render them as harmless as possible;" and it is with the second that he deals. The plan which has been so successful in meeting the violence of exploding gunpowder, should, at least, have a trial in a case of far greater importance—security to life in railway collisions. To refuse this, on account of a few difficulties or inconveniences, seems a sin against Nature herself.