and the general use of improved machinery would not fail to produce a corresponding improvement in the condition of the agricultural labourer, and to accelerate the completion of that progressive revolution, which, since the abrogation of legislative protection, has been rapidly taking place in every department of practical agriculture.

On Double Cylinder Expansion Marine Engines. *By* J. ELDER.

These engines are constructed with the view of getting the greatest amount of power from a given quantity of steam at a given pressure, with less total weight of engines, boilers, and water, and occupying less total space than that occupied by the ordinary class of steam engines on board steam-ships; these engines are therefore expected to have the following properties:—

1.—That with these engines a steam-ship can steam the greatest distance possible with a given quantity of coals.

2.—That a given distance can be performed in the shortest time, on account of the small weight of coals necessary to be carried.

3.—That the greatest amount of cargo and passenger accommodation is obtained, from the small room occupied by the boilers and coals.

4.—That where a given capacity of cargo and passenger accommodation is required, a smaller and consequently less expensive ship is necessary.

5.—The boilers, being less than the usual proportion, are less expensive to replace when required.

6.—The number of firemen and stokers is reduced, and, consequently, the space occupied by them can be otherwise engaged, and their wages saved.

To accomplish these objects, the constructors of these engines have followed the course we now describe. The cylinder capacity is so great as to admit of the steam being expanded to within two pounds of the pressure in the condenser, at the end of the stroke, while the engines are working full power. In order to reduce the shock of high pressure on such a large piston, a cylinder with a piston one third the size is placed close to it. This small cylinder receives the steam direct from the boiler during one-third of its stroke, and is then cut off; this steam is consequently reduced to one-third of its original pressure at the end of its stroke, and then enters the second cylinder, where it is expanded three times more: thus 36lbs. steam is expanded to 4lbs., viz. from 36 to 12 in the first, it then enters the second at 12 and is expanded to 4lbs.; but, as the second piston is three times the size of the first, the load will be the same on both pistons, and the piston rods, cross heads, and connexion rods may be duplicates of each other. The steam and eduction slide valves are wrought with eccentrics. The steam valve is a gridiron with large flap; the eduction valve, which serves for both cylinders, has no lap, and the eduction ports remain open during the entire stroke of the piston, thereby giving a free egress for the steam, and ample escape for water, should it form.

In reversing the engines the eccentrics are made to overrun the shaft till they arrive at the backing catch—a plan which is less likely to cause accident than the ordinary methods. The cylinders are steam-jacketed completely, and then covered with felt and wood. There is a small engine pump for forcing the distilled fresh water from the jackets into the boilers, or to the fresh-water tanks, if necessary.

The boilers now being made for such engines are tubular, with three large superheating uptakes, 2 feet in diameter and 15 feet high, leading up through an oval steam chest to the funnel; this makes a strong form of take-up, where it joins the tube plate, especially in boilers firing across the ship. The feed-pipe of the boilers has twelve spiral convolutions inside the funnel to heat the feed-water. This may be shut off when desirable.

The author then mentions the various vessels in which these engines have been fitted, and shows by comparison with other engines the great saving of expense, combined with greater efficiency.

A Description of a Hand Heliostat. *By* F. GALTON, *S.G.S.*

By this simple instrument the rays of the sun could be flashed with ease and precision upon any required spot. The appearance it produced was that of a brilliant

and glistering star, and its power was sufficient to arrest the notice of the most careless person at ten miles' distance. No sky line was necessary to the distinctness of this remarkable signal, as is the case with semaphores and flags; indeed it was visible to the greatest advantage in front of a dark or hazy background. It could be used with equal facility from any spot where the sun's rays reached it, as from between the trees of a forest or from a boat, as well as from a mast-head or a hill-top. It had another peculiarity, in being enabled to flash its messages in perfect secrecy, except to those who happened to be stationed in the narrow path along which they were sent. Many occasions would arise, especially in war time, where this invention would be of use. If the signaller was ignorant of the whereabouts of his correspondent, he must sweep the horizon with his flash until it had been seen, and a response elicited. For a more detailed description of this instrument, see the Proceedings of Section A.

On the Economy of Water-Power. *By* JOSEPH GLYNN, *F.R.S.*

In this part of England, and in other manufacturing districts where coal is found, the steam engine will generally be preferred to all other kinds of motive power; but in many parts of the British empire, more especially in Scotland and Ireland, coal is scarce and water is abundant, and is now too often allowed to run to waste where its application to turn mills and to work machinery for farming purposes might save both time and money.

Those machines produced at the Paris Exhibition, to which the writer would more particularly allude, are the horizontal water-wheels, some of which were wrongly named Turbines, whereas they were really substitutes for the machines so called.

The Turbine is a machine of re-action, from which the water issues in jets, and the unbalanced pressure opposite the orifice impels the machine and causes it to revolve in the opposite direction. It requires considerable skill in its construction, and careful attention when in use; but the horizontal water-wheel is a much more simple machine, and much less liable to derangement. The water drives round a fan with curved vanes, having a vertical axis and revolving in an iron case, the water escaping at the centre.

The horizontal water-wheels in the French Exhibition consisted of two parts, or wheels, placed horizontally on a vertical axis, one wheel immediately above the other. The upper part or wheel is fixed, and serves to direct the water into the buckets of the lower one,—that is to say, the real water-wheel,—which revolves, and the axle or spindle revolves with it.

The regulators, which determine the quantity of water and the speed of the wheel, may vary in almost every instance, some being mere wooden sluices, some being metal plates pierced with apertures like a ventilator, and some of stout leather strengthened with iron plates, fitting on conical rollers and radiating from the axis. Some of these wheels are very powerful, and carry a spur-wheel upon the vertical axis, surrounded by six pairs of millstones for grinding corn, driven by pinions in the usual way; other wheels, of smaller size and greater speed, drive a single pair of millstones, without the intervention of other mechanism, the axis of the water wheel being also the spindle of the mill-stone.

The mechanical effect of these machines, when carefully made, is said to equal that of an over-shot or breast wheel. Some realize 75 per cent.

On the Cause of Steam-boiler Explosions, and Means of Prevention. *By* J. HOPKINSON.

The author in this paper shows the necessity of increased attention to the form and construction of steam boilers. After noticing the hay-stack, waggon, Cornish, and Butterly boilers, he very fully describes the want of safety in the double fire-box boiler, and states the various causes of boiler explosions. He then says: "I now propose to show you the patent compound safety-valve, which is a prevention against explosions from the causes before enumerated, and the explosions which have taken place from all causes excepting that of a defective boiler, as under all other circumstances steam boiler explosions are rendered impossible."

The patent compound safety-valve comprises two distinct valves, a large $5\frac{1}{2}$ inch diameter valve with flat face and a spherical or ball-faced valve 3 inches in diameter;