No. 1,217.—"On Coal Getting Machinery, as a Substitute for the Use of Gunpowder."[1] By CHARLES JOHN CHUBB.

IT is admitted by mining engineers, that the risks and difficulties attending the working of coal-mines have of late largely increased. The greater depth to which many of the pits are now worked, and the vast extent to which the lateral ramifications are carried, have confessedly created difficulties which call for alterations and improvements in the art and practice of coal-mining.

The benefits to be gained by the improvements now needed may be thus specified:—First, To insure greater safety to the men employed in working; and, secondly, to obtain the coal in a better condition, and, by preventing as much as possible the present loss arising from waste, to make more fully available all the remaining resources of the coal fields. These objects, it must be granted, are of the highest interest.

The most fruitful source of all the accidents which occur in collieries, and indeed of most of the evils attending the working of coal-mines, is undoubtedly to be found in the use of gunpowder, and in the operation of blasting. The firing of a shot often checks the ventilation of a pit, and renders increased ventilation necessary, in order to dispose of the foul gases produced by gunpowder. The concussion consequent on the explosion frequently causes injury to the roof of the pit, involving, as a precaution, the adoption of narrow workings, and a heavy expense for props. The act of blasting is frequently the cause of the ignition of gases escaping from the coal at the time of firing the shot; and it is certainly solely in consequence of the operation of blasting that a naked light (to the use of which most of the colliery accidents may be attributed) becomes an absolute necessity in a pit. To the operation of blasting, also, may be attributed much of the loss incurred by the large per centage of small coal now produced, and the imperfect condition of a great portion of the coal generally. The effect of the concussion upon the coal is to shake it violently, shattering some of it into small pieces, when it becomes mixed with the material from the roof, while much of the remainder is so tender that it is peculiarly liable to break when subsequently handled or screened.

[1] The discussion upon this and the preceding Paper was taken together, and occupied portions of five evenings, but an abstract of the whole is given consecutively.

To abolish altogether the operation of blasting in coal-mines is, therefore, the great change and improvement required; and the problem to be solved is, to ascertain what force can be applied which shall be equally effective, and at the same time break the coal in a more perfect manner. If, in accomplishing these ends, the cost for labour can at the same time be reduced, it will no doubt be admitted, that any suggestion offering a solution of the difficulty is worthy of consideration.

About two years since the attention of the Author was called to the subject, when engaged in coal-mines in South Wales. After investigation, he felt satisfied that some more simple and practicable means of getting coal by mechanical power could be devised than the costly, but skilfully contrived, coal-cutting machines, then being tried with doubtful success. He came to the conclusion, that if hydraulic force could be brought to bear upon the coal from the interior, by a machine of small size, but capable of exerting sufficient force, the coal must yield to its influence, and could be rent asunder in any way that might be required. Following out that conviction, his first idea was to apply wedges, acted upon by hydraulic force; but he found, in practice, that the friction produced by the use of wedges absorbed much of the power, that the wedges themselves were rapidly cut and destroyed, and that the action of a machine thus worked, not by a parallel but by an angular movement, was to imbed its points, when expanded, into the coal, especially into coal of a soft nature, so that a wide expansion of the apparatus was necessary before the coal could be broken out from the solid.

These, and other serious objections to the use of wedges, induced the Author to abandon that system, and to adopt instead an apparatus consisting of several plungers, set side by side in a steel bar, which plungers, when acted upon by water from a hydraulic pump, will separate the bar in which they are set from another bar, formed in the shape of a cover upon the plungers. The pressing apparatus, which has been lately used with perfect and unvarying success, has twelve plungers, and is 25 inches long. It is attached to a hydraulic pump, by a tube 2 feet in length, so that it may be inserted into a hole drilled into the coal to a depth of about 3 feet 6 inches. The apparatus, with the cover on, is $4\frac{3}{8}$ inches in diameter, but it is capable of being expanded to any extent that may be required to break down the coal. When, by the action of the pump, the plungers have reached their limit of $2\frac{1}{4}$ inches, and further expansion is needed, the plungers are readily brought back to their first position by opening an escape-cock for the water, when a liner can be inserted between the plungers and the cover. The operation of pumping again expands the apparatus to the further width of the liner, and this process can of course be repeated *ad infinitum*. The introduction of a liner is a work of no difficulty whatever. It is

done by hand, whilst the pressing apparatus is in the coal, and without detaching the pump. The assertion which has been made that the expansion of this machine could not "be made to exceed $1\frac{3}{4}$ inch" is therefore manifestly incorrect. In practice, however, it is found that the first expansion of the apparatus to $2\frac{1}{4}$ inches is more than sufficient.

In 'getting' coal, it is generally preferred that the excavated material should not be thrown out in the mass; but that it should be cracked and loosened in such a manner that it can be readily removed by hand for 'filling.' This has been for the most part accomplished by the expansion of the apparatus to the extent of even less than 1 inch. If the coal is thrown out, there is risk of injury to the men, and it impedes the operation of filling into the trains and tubs.

The force which the apparatus is capable of exerting will be understood, when it is stated that the collective area of the twelve plungers is 24 square inches, and that the pump can exert a pressure of 12 tons on the square inch; consequently the pressure which can be brought to bear upon the coal is equal to 288 tons.

In the earlier stage of the Author's experiments, he was induced to make a trial in the Harecastle Colliery, Staffordshire, the property of Messrs. Bidder and Elliot. The apparatus used on that occasion was an experimental one, differing in many important particulars from that now in operation, and the cause of the failure, which then undoubtedly occurred, was attributable entirely to the irregularity of the hole which had been made in the coal to receive the apparatus. The difficulty of boring a true hole, $4\frac{1}{2}$ inches in diameter, into any coal, has since been overcome, by means of a drill, by which one man can bore a hole of that size, 4 feet deep, into ordinary coal, in about ten minutes. The hole prepared at Harecastle was 'jumped' out in a very rough manner by a bar, and occupied a man, it is understood, nearly two hours in making. The pressing apparatus then used was not equal to the strain put upon it, in consequence of the irregularity of the hole; and it may be asked, whether such a trial can be fairly referred to as condemning a principle, which had not then been put into practical shape, but which has since been perfected, and is now in successful operation?

Plate 11 will serve to show the action of the apparatus in the South Wales district, where the coal is of the most varied description, and perhaps as difficult to work as any to be found elsewhere in the United Kingdom. The managers of the several collieries have kindly offered to bear testimony to the results which have been achieved, for the most part, in their own presence.

Considered solely in an economical point of view, and not from a higher motive, as a means of preserving life, this apparatus appears to commend itself to the attention of coal-owners. In support of

this it may be sufficient to give the following data: By the present system of blasting, it occupies, on an average, two men ten hours to break down and fill into trains 4 tons to 5 tons of coal, of which 20 per cent., on the average, is 'small,' and so mixed with stone, &c., as to be of little value, while the remainder is much shattered, and therefore more liable to break, when roughly treated, than it otherwise would be. On the other hand, with this apparatus, two men can readily break down 20 tons of coal in one hour, which can be filled, when loosened, at the rate of 10 tons per man per day, the whole of the coal so obtained consisting of large solid pieces. Again, by the present system, in order to break down 500 tons of coal a day, from a 4-foot seam, a 'face' of 600 yards is required, whether as pillar and stall or as long work; and as the several workings containing that amount of 'face' must be kept perfectly ventilated, it is of course an object of great importance if a less amount of face can be made to yield the same quantity of coal, for in that case there will be less space required to be ventilated. This apparatus happily accomplishes this also, for, by its use, 500 tons of coal can be worked out from 300 yards of face, being one-half of the face now required for the same quantity of coal. The working operations of a mine generally can thus be concentrated, and facilities will be afforded for effecting economy in other respects.

In conclusion, it is hoped that enough has been said to impress others with the conviction, that this apparatus will prove to be, at all events, one of the means whereby the use of gunpowder in coal-pits may be rendered wholly unnecessary, and its total prohibition brought to pass, thereby removing one of the chief causes of explosions, and helping to prevent those dreadful calamities which have so frequently occurred of late, and by which so many lives have been sacrificed.

The communication is accompanied by a series of diagrams, from which Plate 11 has been compiled.

[Mr. S. P. Bidder