in good preservation, ox, horse, and the relics of shell-fish, oysters, limpets, and cockle, and undoubtedly some human bones, more especially those of the fore-arm and fingers, but no others.

I hope these imperfect notes may afford instructive discussion among your learned members which may solve the mystery of these ancient productions. I would only venture to offer mine, that this has been undoubtedly "a Roman military out-post," one of the guard stations of the coast.

I hope at some future time to thoroughly examine the whole place, and venture to promise a less hasty and more lengthy paper.

AN ACCOUNT OF SOME EXPERIMENTS WITH THE STEAM JET AS A VENTILATOR FOR MINES. BY MR. F. H. PEARCE, C.E., OF BOWLING, NEAR BRADFORD.

A few months ago, the writer's attention was drawn to certain alterations required in the pumps employed in draining a small colliery in this neighbourhood. The shaft is about 120 yards deep, and the nature of the alterations was such as to put a stop to the working of the pumps for some time; during this stoppage the water accumulated in the workings of the mine, and ascended some distance up the shaft, thus completely stopping the system of ventilation previously employed.

The ventilation of the pit had no sooner ceased, than the accumulation of carbonic acid gas (or choke damp) rendered it impossible for the workmen to proceed. Several attempts of an ordinary character were made to displace the gas but they did not succeed, and there appeared a probability of having to incur some expense before proper ventilation of the pit could be accomplished. Matters
remained in this state for several days, and further attempts were made to get rid of the gas, but still without the desired effect. The completion of the pumps now became urgent, and therefore, the removal of the noxious gas indispensable.

After careful examination of what had been done, and finding it all practically correct, and such as had before been found sufficient for the purpose in most ordinary cases of a similar nature, the writer determined upon trying the effect of a jet of steam, the application of which happened to be exceedingly favourable; and the result was the most complete success; the men were enabled to descend the shaft immediately, and from that time the repairs proceeded, and were completed without the slightest delay or inconvenience from imperfect ventilation. The powerful draft produced in so simple a manner caused the most experienced workmen to regard the steam jet as something extraordinary, and to say the least of it, it was indeed found to be a very useful and efficacious expedient. The writer was previously aware that steam had been employed for the ventilation of mines, many years ago, but he had no knowledge of its ever having been used in the way he applied it in this instance, though he has been subsequently informed of prior and somewhat similar applications attended with equal success. Such applications, however, are by no means common in this district, though there are frequent instances where they may be found exceedingly useful, and this can only be accounted for by the fact that very few of our operative miners are sufficiently acquainted with the capabilities and simplicity of the steam jet ventilator.

It was the writer's intention, after receiving an invitation, to submit to your Society a paper on this subject, but subsequent experiments, made on a small scale, with a view of ascertaining its comparative economy, having convinced
him that the steam jet principle cannot be advantageously employed to any considerable extent for the ventilation of coal mines, he respectfully declines that honour, and prefers giving a brief account of what little he has done in the matter, so far as it appears to him at all likely to be useful to others, which he trusts will be received as a substitute for a paper.

The manner in which the ventilation was effected in the pumping shaft above referred to, may be described as follows:

The shaft, as before stated, is 120 yards deep, and the pump is divided into two lifts; the lowermost lift is effected by means of a working barrel and bucket of ordinary construction, situated a few feet from the bottom of the pit, which delivers the water into a cistern about midway up the shaft. The upper lift is effected by a ram or plunger working immediately above the cistern from which it draws the water, and forces it up a main of seven inches cast iron pipes, which reach the top of the shaft where the water is delivered into an open reservoir. Near to the top of the seven inch main a temporary connection was made with another pipe of the same diameter, and nine feet long, placed vertically; and into the lower part of this pipe was conveyed a piece of $\frac{3}{4}$ inch common gas pipe, with its end turned upwards, the other end of the gas pipe being connected to the steam boiler, close at hand, by means of a stop-cock. This simple arrangement constituted a most perfect ventilating apparatus, the effect of which appeared rather extraordinary. The quantity of steam passed up the interior of the seven inches pipe, from the jet piece, was regulated at pleasure, by means of the stop-cock near the boiler; and thus the ventilating power of the jet could be increased or diminished to any desired extent.

It should be remarked that the workmen had partially removed the clack-door at the bottom of the rising main
before the accumulation of damp had stopped further proceedings, and it was through this aperture that the ventilation was effected. The pressure of steam in the boiler was 201bs. per square inch, and on opening the stop-cock, the velocity of gas, &c. drawn up the pipes was such that a few minutes sufficed to clear the pit of foul air down to the clack-door, and the remainder was effected by attaching temporary wooden pipes.

After observing the rapidity with which the air rushed up the pipes, and finding that only a comparatively small supply of steam was necessary to maintain thorough ventilation of the shaft; it was determined to apply the same principle to ventilate the workings of a small neighbouring colliery, in which not more than ten or twelve persons were employed underground. In this instance the shaft is about sixty yards deep, and the ventilation had been effected by means of wooden air pipes, communicating with the engine chimney, the draft of which constituted the ventilating power. The ventilation was feeble, and at times almost imperceptible, owing to the unfavourable state of the atmosphere; and the circumstance of the case, in other respects, being favourable to the application of the steam ventilator, similar to that already described, a nine feet length of ten inches cast iron pipe was fixed upon the wooden air pipe leading from the pit to the chimney, and the steam jet supplied from a boiler close by was fixed in it; there was also a slide or damper, placed between the cast iron pipe and chimney for the purpose of stopping the communication with the latter. The orifice of the jet-piece was 11-16ths of an inch in diameter, and the boiler pressure ranged from 20 to 30lbs. per square inch. The effect produced by these alterations was a most decided improvement in the ventilation of the mine, and although it has been found inconvenient to keep the apparatus constantly in operation, owing to the con-
It will be observed that the additional parts required in the application of the jet in this, as in the preceding instance, are very simple, and that the apparatus can be used or not at pleasure, by simply reversing the dampers, and opening or shutting the steam tap as may be required.

The effect produced by the chimney itself is pretty good, considering, but on opening the damper, while the jet is in operation, it presents a striking proof of superior draught—the smoke and soot are quickly drawn from the former, and thrown out of the iron pipe with the steam. The results obtained in this case, however, were not at all in accordance with the expectations raised by the apparent success of the former application. The leaky condition of the wooden pipes and other defects were certainly unfavourable, but even with ample allowance for these imperfections, the volume of air drawn through the circuitous course of the mine was by no means satisfactory in comparison with the quantity of steam expended on the jet.

A number of experiments were therefore commenced with a view of forming an approximate idea of the value of this plan of ventilation, as compared with others more generally adopted, and the results were most decidedly in favour of the latter; indeed the expenditure of steam was at once found to be so disproportionate with the useful effect, that there appeared little inducement for further inquiry.

The following is a brief summary of some of the results obtained, with three different jets, viz., a common round jet of 4-10ths of an inch area, and two annular jets, one of an inch and a half diameter, and the other of two inches
and an eighth diameter, but both orifices being of the same area as that of the round one.

<table>
<thead>
<tr>
<th>DESCRIPTION OF JET.</th>
<th>VELOCITY OF AIR IN WOOD PIPES PER MINUTE, IN FEET.</th>
<th>QUANTITY OF AIR DISCHARGED PER MINUTE, IN FEET.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Round Jet.............</td>
<td>1,100</td>
<td>1,650</td>
</tr>
<tr>
<td>1(\frac{1}{4}) inch Annular do.............</td>
<td>1,320</td>
<td>1,980</td>
</tr>
<tr>
<td>2(\frac{1}{2}) do. do.............</td>
<td>1,500</td>
<td>2,250</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BOILER PRESSURE 401bs. PER INCH.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Round Jet.............</td>
</tr>
<tr>
<td>1(\frac{1}{4}) inch Annular do.............</td>
</tr>
<tr>
<td>2(\frac{1}{2}) do. do.............</td>
</tr>
</tbody>
</table>

The steam was supplied from a Cornish boiler of about twenty horses nominal power, but no steps were taken to ascertain the exact consumption of fuel, or the quantity of water evaporated. The firing, however, was such as to shew that the jet with twenty-eight pounds pressure, absorbed about half as much steam as the boiler was able to produce, and with forty pounds pressure, about three-fourths; and the consumption of fuel would probably be one and a half hundred weights, and two hundred weights respectively per hour.

On referring to the above tabular statement it will be observed that although the jets have the same area of aperture, they show different results; that of the annular jet being better than the round one, and the large annular jet still better than the smaller one. It was not ascertained to what extent the enlargement of the jet could be advantageously carried, but the size named gave a decided advantage. The annular orifice can be increased or diminished in area by simply turning round the internal cone, at the bottom of which a screw is formed for the convenience of adjustment.
The preceding results give an approximate idea of what may be expected from the steam jet under similar circumstances. In adapting the principle to the entire ventilation of a colliery of considerable extent, it would be found necessary to employ several such annular jets as the one described. It should, however, be borne in mind that in carrying out the plan on a large scale, a more suitable and convenient arrangement might be adopted. For example, the jets may be applied directly over the upcast shaft, and instead of using several small jets, one only, of suitable area and enlarged circumference, may be used. Such an arrangement would no doubt answer well, and may possibly be adopted with advantage under particular circumstances, but the consumption of fuel and expense of boilers would be great in proportion to the amount of ventilation produced.

ON THE VENTILATION OF MINES. BY MR. J. JEBSON,
MINING ENGINEER, MOLD GREEN, NEAR HUDDERSFIELD.

This is a subject which has excited almost universal attention, and its importance demands the most earnest and patient study on the part of all who are interested in the matter; and though it has been investigated and much improved by the learned and most eminent men in science as well as practice, yet there is room for further progress; and where human life is endangered, there skill and science ought to co-operate, and be brought to bear to ensure safety. The perseverance and industry already bestowed on this all-important subject has not been in vain, as would be more clearly seen if we were to compare the present state of ventilation in mines, and the mode of working in general, with what it was twenty, nay, even ten, years ago; not that...