"The Knox System of Quarrying"

By William L. Saunders

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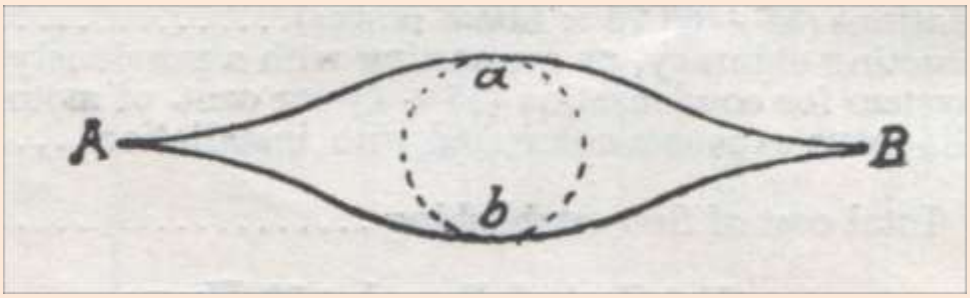
"The philosophy of the Knox blast is simple, though a matter of some dispute. Mr. Knox gives us the following explanation:



> "'The two surfaces, *a* and *b*, being of equal area must receive an equal amount of the force generated by the conversion of the explosive into gas. These surfaces being smooth and presenting no angle between the points, A and B, furnish no starting point for fracture, but at these points the lines meet at a sharp angle, including between them a wedge-shaped space. The gas acting equally in all directions from the center is forced into the two opposite wedge-shaped spaces, and the impact being instantaneous, the effect is precisely similar to that of two solid wedges driven from the center by a force equally prompt and energetic. All rocks possess the property of elasticity in a greater or less degree, and this principle being excited to the point of rupture at the points, A and B, the gas enters the crack and the rock is split in a straight line, simply because, under the circumstances, it cannot split any other way.'

"Another theory has been stated as follows:

> "'A round hole forms on all sides a perfect arch, and if the rock be sound, it is equally strong in all directions. The making of the grooves at opposite sides of the hole breaks the arch at these sides, thus producing two weak sides and two strong sides at right angles with each other. Force being applied within the hold for the purpose of breaking the rock naturally exerts itself in the lines of weakness which have been produced by destroying the arches at A and B, and they being exactly opposite to each other, the result is that the rock is fractured in a straight line, the gas generated by the explosion acting in these lines in the same manner as a line of wedges would applied from the outer side of a rock, with this difference, viz.: Wedges applied from the outer side of a rock are driven inward toward the point of greatest resistance in the rock, while the gas being confined within the

> rock at its strongest part and operating toward the outside, or weaker part, will naturally take that direction which will mostly quickly relieve the pressure, and that is a direct line to the surface.'

"The effect of the Knox blast being practically the same as that of the old Portland system, or that of Lewising, it is natural that we should look into these systems in our efforts to explain why the rock breaks in a prescribed line. Good and true breaks have been made by Lewising, yet there is no V-shaped groove. Equally clear and efficient is the record of the old Portland canister, yet here, too, there are no V-shaped grooves. It might be argued that the Portland canister being embedded in sand or other non-elastic material forms a 'wedge-shaped space,' and here, too, quoting Mr. Knox, 'the gas is forced into two opposite wedge-shaped spaces,' and the impact being instantaneous, the effect is precisely similar to that of two solid wedges driven from the center by a force equally prompt and energetic.

"But we are met by the evidence of the Lewis hole, where there is no 'wedge-shaped space.'

"While it is doubtless true that the 'wedge-shaped space' is an influence which assists the break, and that the breaking of the arch of the hole by the groove renders equally great assistance in that it produces a weak point to start the break, yet the main cause in the Knox blast which acts to direct the break is that the line of force are exerted against the surfaces of the hole A *b* B and A *a* B to a greater extent than upon the surfaces *a* A *b* and *a* B *b*. In other words, there is a greater area of pressure acting upon the surfaces *a* and *b*, and this naturally tends to produce a separation at A and B. The tension is precisely the same as that produced by a line of plugs and feathers, or by a series of wedges driven in a trench.

"Let us assume that an effort was made to split by the Knox holes without an explosion, but by using hydraulic or other pressure within the holes. It is obvious that, were we able to get the pressure high enough, the break would be made in the same way as though it were blasted, and the very purpose of the air cushion in the Knox system is to prevent the shock of the blast from having a bad effect upon the rock. Notwithstanding the cushion there is some shock, and this so far assists the break as to enable the operator to use but little explosive. Were the force exerted through hydraulic pressure, it would be advisable to produce a shock just as a quarryman will strike a block of granite with a heavy sledge in order to start the break while his plugs and feathers are under strain.

"The Knox hole is, therefore, almost identically in principle with the old Portland canister, except that it has the great advantage of the V-shaped groove in the rock, which serves as a *starting point* for the break. It is also more than the Portland canister in that it *requires less drilling*, and the *waste of stone is less*. It is, therefore, not only more economical than any other system of blasting, but it is *more certain*, and in this respect it is vastly superior to any other blasting system, because stone is valuable, and anything which adds to the certainty of the break adds to the profit of the quarryman.

"It is doubtless true, notwithstanding the greater area of pressure in a Knox hole, the break would not invariably follow the prescribed line but for the V-shaped groove which virtually starts it. A bolt when strained will break in the thread whether this be the smallest section or not, because the thread is a starting point for the break. A rod of glass is broken with a slight jar, provided a groove has been filed in its surface. Numerous other instances might be cited to prove the value

of the groove. Elasticity in rock is a pronounced feature, which varies to a greater or less extent, but is always more or less present. A sandstone has recently been found which possess the property of elasticity to such an extent that it may be bent like a piece of steel. When a blast is made in the Knox hole, the stone is under high tension, and in being elastic it will naturally pull apart in such lines of weakness as grooves, especially when they are made, as is usually the case in the Knox system, in a direction at right angles with the lines of least resistance.

"Horizontal lines are frequently put in and artificial beds made by 'lofting.' In such cases where the rock has a 'rift' parallel with the bed, one hole about half way through is sufficient for a block about 15 ft. square, but in 'liver' rock the holes must be drilled nearly through the block and the size of the block first reduced. *Stone*."