The productivity of mining machines can be improved by increasing the motor power and reducing the energy consumption.

The energy expended on coal cutting can be reduced by reducing the yield of fines and small classes of coal, and also by using splitting heads in cutter-loaders. Academician N. V. Mel'nikov [1] has indicated the promise offered by research and development on splitting cutters in cutter-loaders.

At present various techniques for detaching coal from the seam have been investigated. Kichigin et al., [2] describe a cutter-loader, tested in industrial conditions, which cuts coal by splitting it off from the seam by means of hydraulically driven metal levers inserted into a cut made by the circular cutter bar of the machine.

Coal can be split from the seam in other ways. In the present state of technology we can develop and study high-capacity splitting drill cutters which can break the seam with minimum relative area of cutting, giving minimum yield of fines, and with minimum possible energy consumption, which is made possible by the very low tensile breaking strength of coal. Our investigations lead us to the conclusion that it is technically possible and economically advantageous to develop cutter heads which break the coal with an energy consumption less than that of present-day cutter-loaders by a factor of three to four. This would permit us to increase the output of winning machines with presently available electrical pit equipment. The energy consumption of coal splitting can be reduced to 0.01-0.04 kW-h/ton, i.e., by a factor of about 10-20 [2].

To make a comparative analysis with drilling splitting cutters we chose cutters which work the rock with annular chain bars. To estimate the yield of fines we analyzed the relative face cutting areas of various cutter heads, since it is known that when coal is cut in a borehole or slot it is all reduced to fines.

The relative area of cutting of a cutter-loader with a circular cutter bar is

\[ S_{rel} = \frac{2b}{m} + \frac{b}{B} - \frac{2b^2}{Bm}, \]  

(1)

where \( S_{rel} \) is the relative cutting area, \( b \) is the vertical depth of cut in meters, \( m \) is the worked seam thickness in meters, and \( B \) is the breadth of cut of the cutter head in meters.

Table 1 lists the relative areas of cutting for cutter heads with various theoretically possible values of the worked seam thickness and breadth of cut, the height of cut being 0.12 m.

Analysis of the relative cutting area of circular cutter heads, listed in Table 1, showed that for all possible values of the breadth of cut in seams 0.5 m thick and for any possible seam thickness with a breadth of cut of 0.25 m, the relative cutting area is over 50%. Consequently in these conditions more coal will be reduced to fines by the cutting heads than during winning by any present technical means; therefore we can infer that little promise and poor competitiveness will be manifested by cutter heads in these ranges of breadth of cut and seam thickness.
Assuming that for cutter-loaders loading a face conveyer the quantity of fines is increased by 10–15%, we can confirm the well-known conclusion that cutter heads are competitive, as regards yield of fines and coal quality, with drum and auger units when the parameters under investigation range from 1.0 to 1.5 m. For a breadth of cut and seam thickness of 2.0 m, the relative area of cutting by cutter heads is 17.3%; cutter heads have yields of fines approximately equivalent to those of ploughs and chipping drills.

To make a further 10–15% reduction in the relative cutting area of cutting heads, it is necessary to reduce their parameters; the worked thickness of the seam must be reduced to 10–15 m for a breadth of cut of 2.5–3.0 m. We must add that for seam thicknesses of over 1.0 m, all cutter-loaders with cutting heads have auxiliary heads to break the coal outlined by the circular cutter bar, increasing the relative cutting area over that given in Table 1. Furthermore, at the maximum seam thickness and breadths of cut investigated by us, the cutting heads were inoperative owing to the great length of the cut slot, leading to clogging of the cutting chain with fines and loss of productivity.

One way of improving coal quality is the creation of borehole splitting heads. In this article we will analyze such a head, intended for work in a long extraction face. The drilling unit of this head can drill holes throughout the extracted thickness of the seam and breadth of cut simultaneously and continuously while the cutter-loader moves along the face without stopping. To analyze the borehole cutter, we assume that the number of holes is greater than one, and that all the holes lie in one row between the floor and roof of the seam, with equal spacing between centers. To improve the reliability of the work the end holes must be drilled at some distance from the floor and roof. We will call this distance \( h/2 \). Then the number of holes is

\[
n = \frac{m}{h},
\]

and the area cut in them is

\[
S_c = \frac{nd^2n}{4},
\]

where \( d \) is the diameter of the holes in meters. Assuming that the total area of the cutter-loader face is equal to the product of the worked seam thickness \( m \) by the breadth of cut \( B \), the relative area of cutting of the borehole head, after some simple calculations, is found to be

\[
S_{rel, bb} = \frac{nd^2}{4B}.
\]

From Eq. (4) we see that the relative area of cutting by the borehole head does not depend on the extracted thickness of the seam. We note that the breadth of cut of one row