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H. H. DeLong

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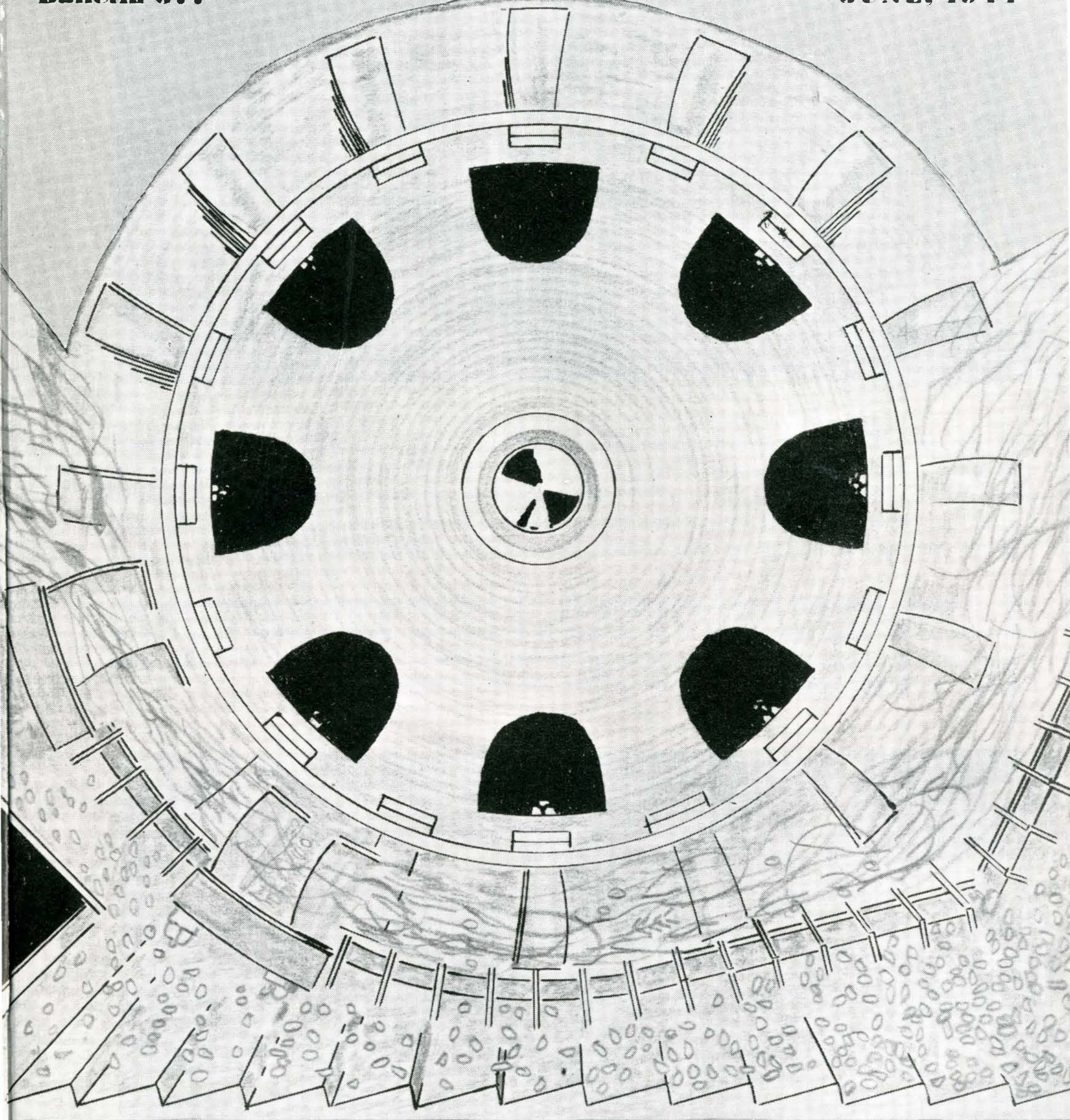

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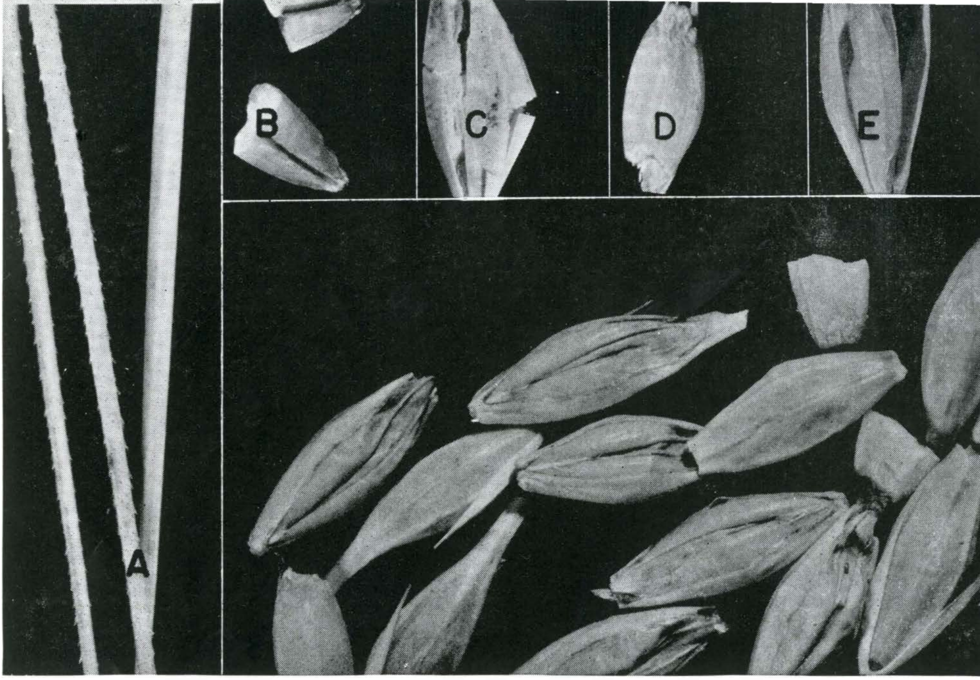
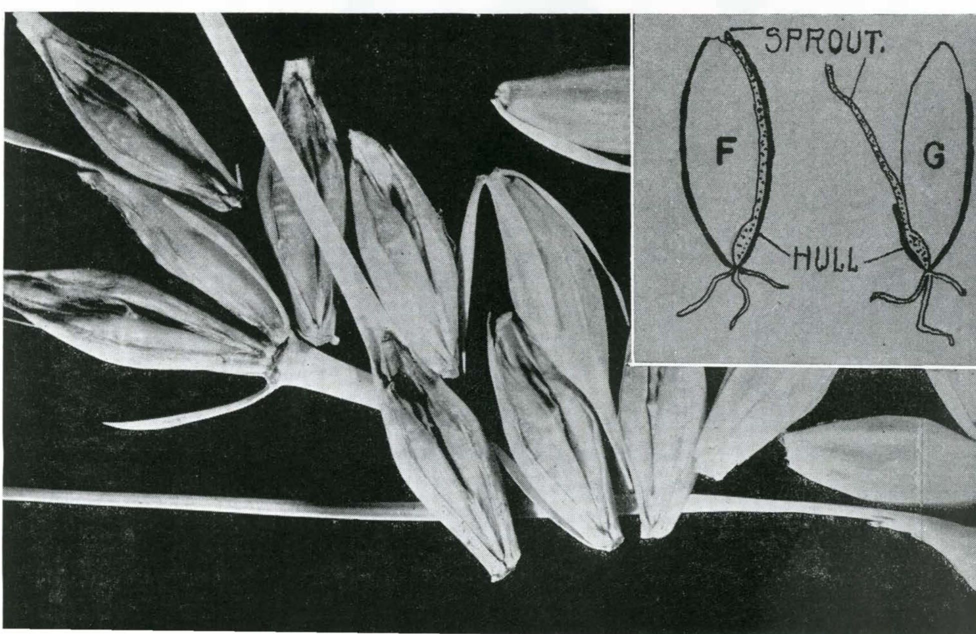


Fig. 1A (left) Two rough beards undesirable in feed and (right) smooth barley beard. Severe threshing and an adequate wind blast can remove all beards and blow them out of the grain. In this process some kernels may be cracked (B), crushed (C), skinned (D), or frayed (E). Such kernels do not lower the feeding value of the grain. The lower part of Fig. 1 shows grain suitable for feeding but having too many damaged kernels to be used as malting barley.

Fig. 2 (insert) Desirable kernel for malting (F). The hull is not destroyed and so forces the sprout to grow under it to the tip of the kernel. A damaged kernel (G) allows the sprout to come out of the hull and be broken off in the stirring process. The kernels in the lower part of Fig. 2 are from a good malting sample. There are no damaged kernels.



CYLINDER ADJUSTMENTS for Threshing Barley

By H. H. DeLong, Associate Agricultural Engineer

Barley is one of the easier grain crops to thresh, provided that it is well matured, properly dried out, and in the proper form for the thresher or combine.

Both farmers who feed barley and farmers who market it usually want it threshed severely enough to remove all beards, especially when the barley is rough awned. Farmers who market it want it threshed well because severe threshing and removal of all beards, together with proper setting of the cleaning shoe, tends to increase the test weight. This weight partly determines the grade that a sample of barley receives. When test weights are the only deciding factor in determining a grade, adjustments of the threshing machine or combine may make a difference of as much as one market grade.

Use for Barley Determines Cylinder Adjustments

Barley sold for malting purposes must measure up to rigid standards. The Handbook of Official Grain Standards of the United States gives a lengthy set of rules and requirements that a sample of barley must pass before it is graded "malting" barley. These requirements deal with test weight, variety, percent of sound barley, percent of heat damage or disease, foreign material, mixtures, and percent of broken or mechanically injured kernels. The malting trade has further restrictions on accepting barley from certain geographical areas and barley that lacks the desired mellowness of kernel.

The thresher and combine operator need not be concerned with all of these requirements. But he directly controls the amount of broken and skinned kernels and the cleanness of the grain sample. The adjustments that he makes may also have a bearing on test weight because of the amount of undersized and light kernels left in the grain. The thresherman should be able to adjust his machine to please two patrons: the feeder and the grower of malting barley.

Barley for the feeder. The feeder wants a severe job of threshing done with all beards removed and blown out. When the rough awnes of some varieties of barley are left in feed, they irritate mouths of the animals that eat this feed.

Barley for the maltster. The malting trade, on the contrary, does not object to a few beards remaining on the kernels, or a few kernel clusters of partially threshed heads. Broken and skinned kernels are not wanted by the maltster. Samples of grain with more than 5 percent of damaged kernels cannot be given a "malting" grade. Careless setting of cylinder speed or concave clearance can easily make an otherwise suitable barley unfit for the malting process.

The best malting barley has kernels of large, even size and few if any broken, skinned, or frayed kernels. The sample will germinate uniformly. The sprouts will all grow at about the same rate and will progress along the barley kernel, under the hull, protected by the hull. The sprouts of skinned or frayed kernels will emerge from the hull too soon and may be broken off in the mixing process. When they are broken off, growth stops and the desired enzymatic action stops. Stopping this action lowers the quality of the product because the enzymes do not make the desired chemical change in the starchy part of the kernel. The illustrations on page 2 show clearly the kinds of mechanical injuries discussed here.

Investigations of Cylinder Adjustments

Investigation of the problem of proper adjustments of all types of threshing cylinders was begun by the South Dakota Agricultural Experiment Station in 1939. Field observations were made in Brookings County and five other counties —Deuel, Hamlin, Kingsbury, Lake, and Codington. Samples of threshed barley were collected from 26 machines. The cylinder adjustments were recorded and later counts were made for percentage of cracked or damaged kernels. Only 7 of 17 combines and 2 of 9 threshers were delivering threshed barley with less than 5 percent of mechanically injured kernels.

Nearly every sample of barley obtained was Wisconsin 38 or Odessa, both of which are malting varieties. Malting barley was bringing a premium of 2 to 5 cents per bushel at that time.

Drag elevators and blower elevators were tested to see if they caused mechanical damage. The drag elevator showed no noticeable additional injury. The blower elevator showed 0 to 2 percent increase in mechanical damage when run at recommended speeds. Severe cracking occurred when the blower was run above recommended speeds.

In the 1940 season, another series of tests showed that with the rasp bar cylinder, clearances as close as one-fourth inch could be used on barley which was rather damp and tough. Cylinder speeds of 5,000 to 5,800 linear feet per minute were used. Barley varieties having soft chalky kernels were observed to crack much more than the hard flinty varieties. Greater cracking with bent cylinder teeth or misaligned concaves was demonstrated by a series of tests.

Carefully Controlled Tests Necessary

The first 2 years of investigations showed the necessity of carrying on a series of tests under conditions where variations in temperature, variety, ripeness, and humidity could be held to a minimum. Thirty-six different test runs were made in quick succession on one uniform field of barley in a 2-day period when all variable factors were at a minimum. The tests were made at the University of Minnesota Experimental farm at Morris, Minnesota, during July, 1941. All three types of threshing cylinders described on pages 6 and 7 were used. Records were made of the cylinder speeds and concave clearances. Later careful counts were made of the kernels to find the percent of mechanical damage.

Because the detailed results of these tests are published elsewhere[1] only a brief summary of them is given here.

Table 1. Performance of Different Types of Threshing Cylinders

(Moisture content varied from 12 to 15 percent and test weights from 45 to 47 pounds per bushel)

Type of cylinder	Range of speeds	Best speed	Range of clearance	Best clearance
Rubber-Faced Bar	4,700-6,000 FPM	5,100 FPM	5/16″ to ½″	⅜″
Rasp Bar	4,600-5,800 FPM	5,000 FPM	½″ to ⅝″	½″
Spike Tooth	5,600-6,400 FPM	5,600 FPM	2 rows {up, medium, down}	2 rows up

[1] H. H. DeLong and A. J. Schwantes, "Mechanical Injuries in Threshing Barley," *Agricultural Engineering,* March, 1942.

How to Secure Right Cylinder Speed

Thresher cylinders must be run at their rated speed because all other thresher parts are driven from the belt pulleys on the cylinder shaft. Two rows of concaves are customarily used for barley. Both cylinder and concave teeth should be straight. The concave should be aligned so that the clearance on either side is the same. The clearance between concave teeth and cylinder teeth varies from 5/32 inch in the raised position to 7/32 inch in the lowered position because the teeth taper slightly.

Cylinder speeds are given in feet per minute so as to make figures consistant for cylinders having large or small diameters.

TABLE 2. APPROXIMATE DIAMETERS OF COMBINE CYLINDERS BY MAKES AND MODELS

Diameter	Make and model
in.	
15	Allis-Chalmers "40" & "60"; Avery "Harvest All"; John Deere 11A & 12A; McCormick-Deering "42"; Massey Harris "Clipper"; Oliver "2"
16	Case "F"; Cockshutt "6"; McCormick Deering "61"
17	Huber, Mpls.-Moline "69"; Woods Bros. 4-F, 5-F, 7-F
18	McCormick-Deering "22", "31-T", "51-Hillside"
19	Gleaner, "Six-T", "S", "J", "H", "E", "F"
20	McCormick Deering "31-RD"; Oliver Grain Master, 6, 8, 10, 12, 20, 22, 30
22	Avery "La"; Case "A-6", "C", "K-12", "V"; John Deere "7", "5A", "17", "9", "33", "35", "36", "36A", "36B"; Harris; Massey Harris "15", "17", "18", "14", "20 S.P."; Minneapolis-Moline "J", "G-3"

TABLE 3. SPEED OF CYLINDER BARS AS RELATED TO REVOLUTIONS PER MINUTE

Speed of cylinder bars in feet per minute	**5,000**	**5,200**	**5,400**	**5,600**	**5,800**	**6,000**
Diameter of cylinder	Revolutions per minute corresponding to above speeds					
in.						
15	1,272	1,322	1,373	1,425	1,477	1,528
16	1,192	1,242	1,290	1,340	1,385	1,435
17	1,122	1,169	1,212	1,260	1,300	1,350
18	1,060	1,102	1,145	1,190	1,230	1,272
19	1,005	1,046	1,086	1,128	1,166	1,205
20	957	996	1,032	1,071	1,110	1,150
22	872	907	942	978	1,010	1,045

Three Types of Cylinders

Rubber-Faced Bar Cylinder: The rubber-faced bar cylinder shown in Fig. 3 at right, is made in 15-, 16-, or 17-inch diameters, depending on the make and model. It is used only where the cylinder is nearly the full width of the cutter bar and feeder. The rubber faces (A) are securely bonded to the angle iron bars, and when they are worn away they can be replaced. Six to eight such bars are used and mounted with a slight spiral to reduce shock and vibration. A combination of two of the following types of concaves are used—rubber-faced shelling plate (B), steel-jacketed rubber bar (C), channel iron (D), or a corrugated metal bar (not shown). Concaves are mounted on a perforated steel screen (E).

Cylinder speeds can be varied usually between 400 to 1,600 r.p.m. (revolutions per minute) by variable-pitch V-belt pulleys. Cylinder clearance measured at (G) is adjusted on most models by raising or lowering each end of the cylinder by adjustment (F). Such adjustments take considerable time if the operator checks clearances with a feeler gauge.

Rasp Bar Cylinder: The rasp bar cylinder shown in Fig. 4 is used on many combines. When such a cylinder is "full width" of cutter bar, its diameter is 15 or 16 inches. The narrower cylinders have diameters varying from 19 to 22 inches. There are six to eight of the corrugated cylinder bars (H & K). The concaves are usually of channel iron (I) and are mounted on a perforated steel screen (J). The cylinder to concave clearance may be regulated by spacer shims (L), by adjustments like (F) Fig. 3, or by a quick change lever (S) in Fig. 5. Cylinder clearance is measured at (M) Fig. 4.

The small diameter cylinders have a speed range of 400 to 1,600 revolutions per minute. The larger cylinders have speeds of 300 to 1,200 per minute.

Adjustment (N) allows the operator to turn one half of the drive pulley on thread (O), thus changing the effective pulley diameter. Cylinder speeds are changed by increasing the diameter of one pulley and decreasing the diameter of the other.

Spike Tooth Cylinder: The spike tooth cylinder shown in Fig. 5 is used on all American threshers and on some of the larger combines. Diameters are 22 inches or larger. There are 9 to 12 bars (P) on the smaller sizes, but larger cylinders have more bars. The steel cylinder teeth (Q) travel between concave teeth (R), thus creating many small vertical threshing spaces as at (X). For a given width the spike cylinder therefore offers more threshing surface than the other types.

Cylinders are provided with six rows of concave teeth. Two, four, or six rows may be used, depending on the crop or condition of the grain. The ratchet lever and eccentrics (s) allow raising or lowering the concaves. The space between the teeth is changed very little by the adjustment. Lowering the concave reduces the amount of surface of one tooth passing another. All teeth should be straight. Bearings (V) should allow no end play. Adjustment (U) allows proper sidewise setting of the concaves.

Thresher cylinders are made to run at only one speed.

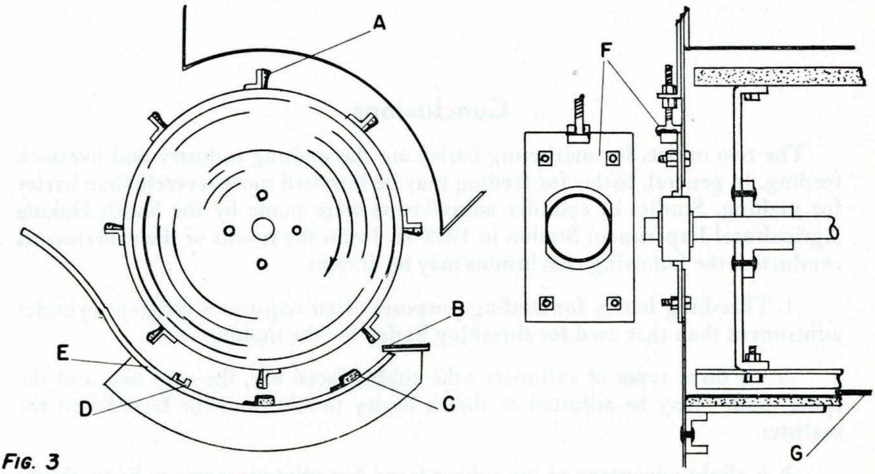


FIG. 3

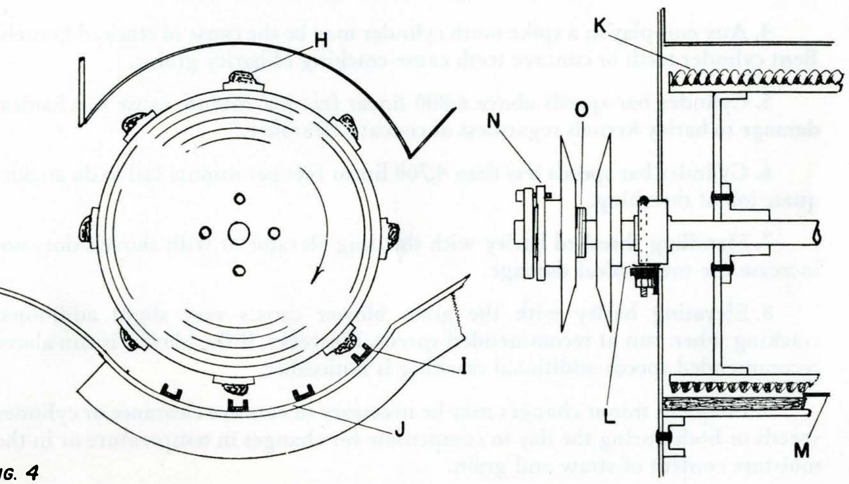


FIG. 4

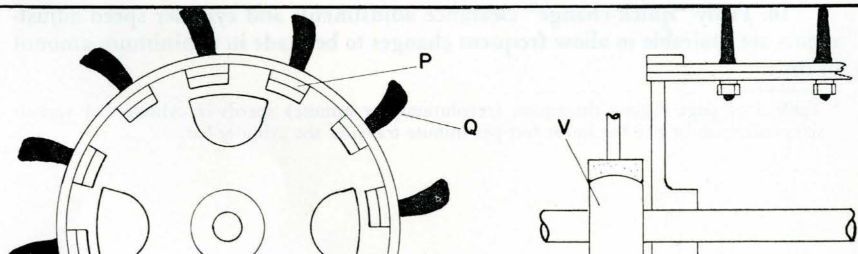


FIG. 5

Conclusions

The two outlets for marketing barley are the malting industry and livestock feeding. In general, barley for feeding may be threshed more severely than barley for malting. Studies of cylinder adjustments were made by the South Dakota Agricultural Experiment Station in 1939-41. From the results of the experiments conducted, the following conclusions may be drawn:

1. Threshing barley for feeding purposes often requires a different cylinder adjustment than that used for threshing barley for the malting trade.

2. All three types of cylinders—the rubber-faced bar, the rasp bar, and the spike tooth—may be adjusted to thresh barley to suit both the feeder and the maltster.

3. A slight advantage of the rubber-faced bar cylinder seems to be its ability to thresh without excessive cracking or skinning barley kernels.

4. Any end-play in a spike tooth cylinder may be the cause of cracked kernels. Bent cylinder teeth or concave teeth cause cracking of barley grains.

5. Cylinder bar speeds above 6,000 linear feet per minute cause mechanical damage to barley kernels regardless of concave clearance.[2]

6. Cylinder bar speeds less than 4,700 linear feet per minute fail to do an adequate job of threshing.

7. Handling threshed barley with the drag elevator or with shovels does not increase the mechanical damage.

8. Elevating barley with the grain blower causes very slight additional cracking when run at recommended speeds. However, if the blower is run above recommended speeds additional cracking is noticeable.

9. Frequent minor changes may be necessary in concave clearance or cylinder speeds or both during the day to compensate for changes in temperature or in the moisture content of straw and grain.

10. Truly "quick-change" clearance adjustments and cylinder speed adjustments are desirable to allow frequent changes to be made in a minimum amount of time.

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[2] Table 3 on page 5 gives the r.p.m. (revolutions per minute) speeds of cylinders of various sizes corresponding to the linear feet per minute travel of the cylinder bar.

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