IMPORTANCE OF GRAIN SLICING IN THE MILLING INDUSTRY AND IN AGRICULTURE

By

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I. Theory of slicing

Since the Semensect (grain slicing machine) "System Rajkai" had won the International Grand Prix of the Brussels World Exhibition 1958 and had been successfully demonstrated in Moscow and Leipzig, this machine was often mentioned on the wireless and many articles were published in domestic and foreign newspapers and technical periodicals dealing with its utilization in the milling industry and in agriculture. A great number of these publications were based on inadequate information which often leads to misunderstanding.

On behalf of the National Institute for Corn and Flour Research we deem it necessary to make public the work we have done so far in the present publication of an informative character and to give some details of the experiments carried out on a pilot-plant and full-plant scale, the results of which are promising considerable and notable success. We hope that this study will serve as a basic material for a starting dispute, likely to promote the final solution of the problem, and we shall be able to advance our work by making use of the different views and comments received from various sides.

In the present study I do not intend to explain all details, because — although on both fields industrial practice has been started — some of these details still need more investigation and experiments, since they are the object of research in course, and the study of their effect on agriculture and the evaluation of their results need several years more.

Beyond the investigation carried on for decades regarding the instrumental evaluation of the production of wheat-corn and of the sorting experiments, the National Institute for Corn and Flour Research has been carrying out experimental work to study — among others — the direction and extent of the breaks and gaps on the wheat-grain. Most of these breaks are caused by the rasp bar of the peg drum and only a very small percentage is caused by other external mechanical effects, such as classifier, cleaning during storage, and in the milling industry, etc. Cracks are visible not only on the skin but in most cases they can also be found under the apparently intact, unhurt shell, in the endosperm. This is natural, because the internal floury part can be loosened by much less force than the more leathery grainshell.

In most cases the splitting and crackling tests carried out on the basis of these experiments have justified our previous statements and the fact that splitting can most easily be effected by a force acting perpendicularly to the longitudinal axis of the grain, because this direction corresponds best to the cracking tendency of the grains. Upon perception of this fact Mr. Paul Rajkai, Kossuth Prize winner, chief of the Scientific Department in our Institute has started with his slicing experiments, aiming at the substitution of the cracking roll and wanting to find a better solution for the work with the cracking roll. By slicing milling he hoped

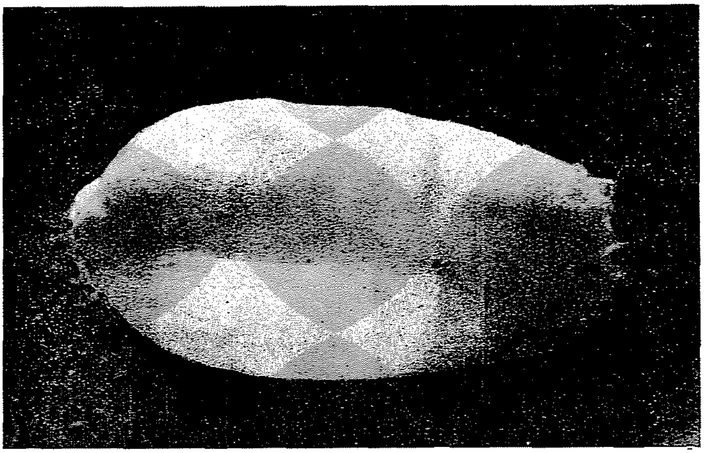


Photo 1. Crack on the grain caused by the rasp bar of the peg drum

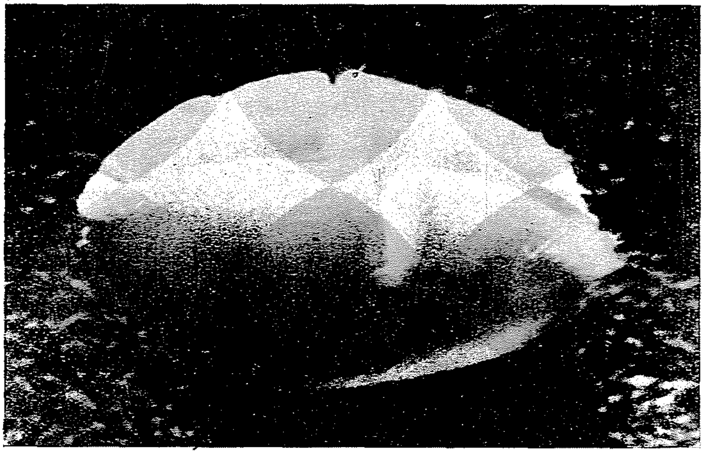


Photo 2. Crack intentionally made on the wheat grain

to produce more regular half products in determined size and form, where the further processing and the quality of the flour obtained can be controlled.

II. Description of the slicing machine

Before giving a picture of the results of experiments in the milling industry and agriculture, I would like to give a brief explanation on the slicing machine and the principle of its operation.

Fig. 3b shows the schematical cross section of the slicing machine, and its more important components, resp., which are the following :

1. Grain gathering rolls.
2. Brushes.
3. Slicing knives.
4. Groove cleaners.

1. The surface of the gathering roll is formed by plain and gear wheel shaped rings fitted on the roll alternating with each other.

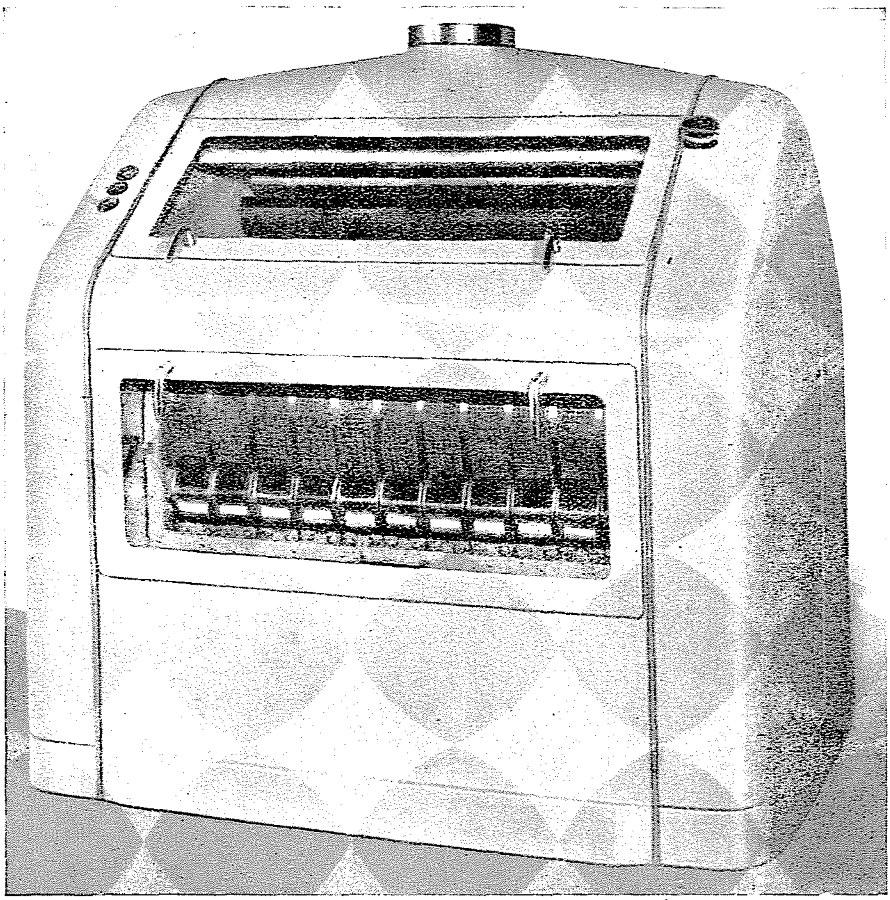


Photo 3a. Semensect "System Rajkai"

These rings jointly form the pockets, which gather, hold, and convey the grain. The flanges protruding on the sides of the rings are placed deeper than the deepest points of the pockets, and form the so-called "grooves", which are penetrated by the slicing knives after cutting the grains. The pockets are situated close to each other on the surface of the cylinder jacket, more thousands in number. Thus its arrangement becomes very similar to the well-known disc separator with the difference that the pockets are on the external surface of the cylinder jacket and not inside. On the slicing machine of great capacity there are two gathering rolls rotating at identical speed in opposite direction and the grains fall into the pockets of these two rolls, which convey them to the brushes.

2. The rotating brushes are located above the gathering roll in the direction of the tangent, and they have two tasks: partly to help the positioning of the grains in the pockets, partly to remove the superfluous grains.

3. The slicing knives are moving in the grooves formed by the rings of the gathering roll. The grooves cross also the pockets, and the grains being in the pockets are cut by the knives into pieces corresponding in

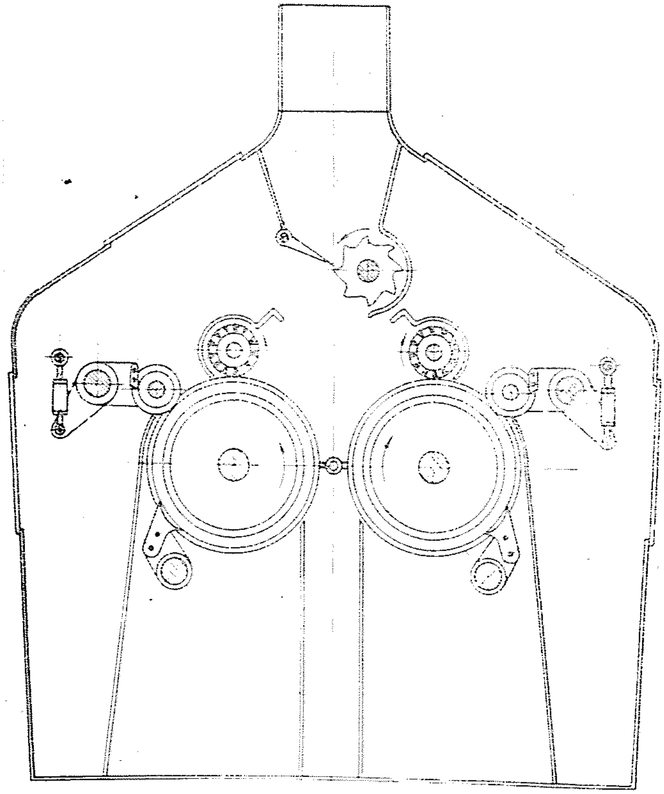
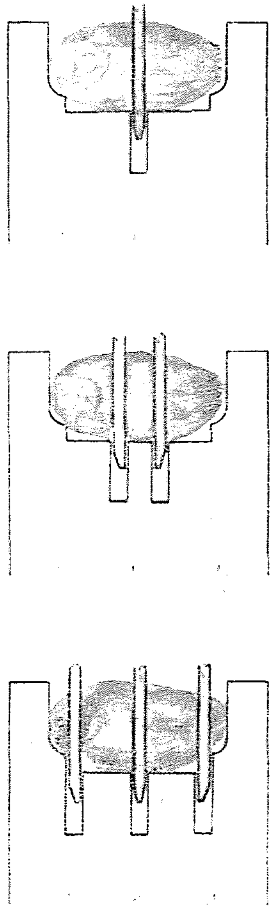


Photo 3b. Schematic drawing of the slicing machine

number to the number of grooves and knives, resp. The circular shape knives are made of steel plate and are fitted on their shaft in a tiltable or adjustable way, thus knives can be changed while the machine is in operation, too. The knife discs are being driven only by the grains in the pockets of the gathering roll, they have no direct drive.

4. When slicing, the middle parts of the grains are squeezed between the side-plates of the knives, and carried by them. At an adequate place they are removed by the help of the comb fittings between the knives from where they fall into a common collecting channel. The grooves are cleaned by the groove cleaners. These remove the floury material possibly pressed into the grooves when slicing.



I.

II.

III.

Photo 4. Slicing methods

The end parts remain free in the pockets and continue the rotating movement ; after further rotating they fall into a separate collecting channel. By this process the slicing machine separates the middle parts from the end parts without any classifier equipment.

Theoretically the grain can be cut at discretion into any number of slices but practically the grain size, the thickness of knives, and size of regular shape bran parts determine the slicing. Slicing into 2—4 pieces seems to be the most suitable according to the different slicing purposes. Fig. 4 shows a few slicing systems applied with domestic wheats ; Schedule No. 1 shows the weight distribution per cent of the parts thus produced.

Schedule No. 1

Weight of slices obtained by various slicing methods in the percentage of the total weight of the wheat grain

(1) Slicing method	Quantity obtained in weight percentage			
	(2) Germ-end	(3) Middle part (1)	(3) Middle part (2)	(4) Awn-end
I	56	—	—	44
II	42	20	—	38
III	8	43	42	7

III. Application in the milling industry

When slicing in the milling industry it is advisable to separate the cone shaped end parts of bigger husk content, and to use only the middle parts for further processing, especially in cases, where the obtention of fine flour and the diminution of the ash-content is required. In this case it is advantageous to exert side pressure, too, on the endosperm because thus its floury parts undergo a structural change and shall be more easily separated from the more leathery husk and aleuron layer, which gets into the bran in the course of further treatment. Therefore the slicing knives are not necessarily very sharp; besides slicing they also have a destructive role especially on the starch stock of the endosperm.

To reach the goal mentioned above the system of slicing into 4 pieces seems to be the most suitable as schematically shown in Photo 4. With this system the ash content calculated on a dry content basis of the products obtained from a wheat of 1.900% ash content will be the following:

Ash content of the end parts amounting to 15% of the grain weight is 2.800%; the ash content of the middle parts amounting to 85% of the grain weight is 1.740%. The advantage of the system is due to the fact, that we can start with the gradual processing at a rate of 1.740% ash content of the middle part, instead of the 1.900% ash content of the whole grain. In the middle part a substantial loosening has taken place and thus the separating of the endosperm from the corn and seed skin is also substantially simplified as compared to the technology applied hitherto, and the quantity of flour with less ash content can be increased.

The technology of the milling is also facilitated by that indisputable advantage of the machine that by slicing pieces of definitive shape and nearly uniform size are obtained which are bordered on both sides by huskless flat-plates. This was not possible with the so-called classical milling system. The roll is not suitable to get the grains well ordered between the breaking rolls. The grain fed through the feeding throat occupies a haphazard position in the flutes of the breaking rolls in horizontal, vertical or even in inclined position. The flutes effect their comminution accordingly, and primary grinding products of various size and shape from the flour of grit — the quantity of which cannot be neglected —, until flattened wheat grains are obtained in various percentages corresponding to the moisture content of the wheat. These products cannot be processed further according to the optimum requirement, and the technology to be applied has to be chosen according to the fractions being present in the highest percentage. On their other hand — as it was already mentioned —, the wheat slices obtained by controlled reducing process are of nearly uniform size, form and dimension, thus it enables us to apply the most suitable grinding method and to reduce the number of passages.

Grinding experiments parallelly performed with unbroken and sliced wheat have proved that in case of identical starting ash content the advantage of slicing already appears with the first breaks. The ash content of the white product of the first break is substantially lower than that of the first break of the whole grain. For example the quantity falling through a sieve of 22 mesh with medium guidance is 36% at the grinding of unbroken wheat of 1.900% ash content, its ash content being 1.18%; whereas when grinding the middle parts of sliced wheat with the same guidance, the quantity falling through a sieve of 22 mesh is 48% and its ash content is only 0.95%. This proves that not only the separation of the end and middle parts takes place, but also the advantageous effect of loosening in the internal structure of the endosperm appears as a consequence of slicing. The endosperm can be removed without tearing the skin-ring. This turning out of the endosperm takes place under the influence of a lesser cracking effect, too, thus the white product will have bigger granulates with the same output.

The slicing technology makes it possible to produce substantially more white products already with the first breaks. This enables us to reduce the number of passages and to obtain flours of less ash content also in the case of a higher reduction percentage.

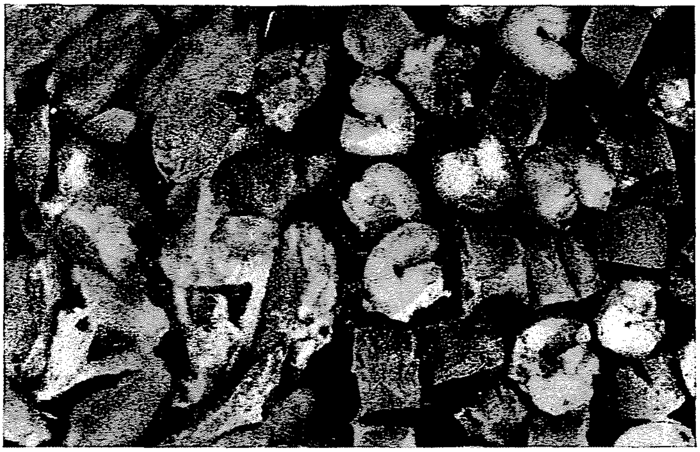


Photo 5. First break produced by rolls and middle parts produced by slicing machine

Schedule No. 2

Machinery of a normal milling and a slicing milling with a capacity of 3 wagons/day

(1) Denomination of machines	Requirement (2) with slicing machine	(3) with normal milling	Deviation (4) in natural unit	(5) in percentage
Slicing machine .... pc	1	—	+1	—
Rolls .... pc	8	16	—8	—50
Overall length of rolls ...... mm	5 400	10 800	—5400	—50
Roll length .... mm/wg	1 800	3 600	—1800	—50
Corundum .... pc	2	2	—	—
Bran thrower .... pc	2	—	+2	—
Total sieve surface .... m²	48	83.2	—35.2	—42.3
Sieve surface .... m²/wg	16	27.7	—11.7	—42.3
Grits purifier .... pc	3	4	—1	—25
Width of purifier .... mm	2 100	2 800	—800	—28.6

Schedule No. 3
Quality of flours obtained by slicing technology compared to the standard quality

(1) Kind of flour	With slicing (2) Extraction rate %	(3) Ash %	Standard (4) Extraction rate %	(5) Ash %
Bl. 55	44.33	0.468	35—37	0.550
Bl. 112	36.20	1.080	41—43	1.120
Total ..	80.52	0.744	77—78	0.864
According to Mohs scale	80.53	0.930	78	0.812

As a consequence of the reduced passages the probability of breaking the tougher skin parts is lessened and the more gentle extraction results in the decreasing of the ash content of the flours and the lower heating during the grinding procedure. In the Schedules No. 2 and 3. I am presenting the installation of a Hungarian milling of 3 wagons/day capacity with an average machine park; the deviations in natural measuring units and in percentage, and the development of quality in comparison with the standards.

Summarizing the application of the slicing machine in the milling industry, the following results are worth mentioning:

There are substantial reduction in the passages, in the total and specific length of rolls, in the sieve surface and in the width of grits cleaner; all these prove the advantages of the slicing milling system.

The most important factor is the improvement in the quality of the flour as it can be realized also from the enclosed schedules. With the slicing method fine flour of lower ash content can be produced in higher percentage, which is in our case even more advantageous than the values of the Mohs scale internationally accepted.

This improvement in the flour quality offers such advantages that cannot be expressed in terms of money because its scientific and economic value is much bigger than the price difference between the fine and bread flour.

The end parts produced by slicing can be sold not only as fodder flour, but in consequence of their high vitamin content they can be used for the production of special flours, sperm oil, and for poultry feeding, etc.

The simplified milling system diminishes the dimensions of the building-space required for the plant, reduces the passing of the material to be ground in the milling system, and the route of the internal material handling.

As a consequence of all these simplifications it becomes possible to achieve a substantial increase in capacity within a given building either with the actual machine park, or at a very low investment cost in machinery and to improve simultaneously the quality of the flour.

IV. Application in agriculture

Besides the milling industry, the slicing machine plays an important part also in agriculture. In this respect practical results can be realized more easily, partly in saving seed and increasing straw strength, partly by the surplus in harvest. The change taking place in metabolism, in the biological processes of sprouting and individual development as well as in the measure of growth of roots and stem show fully new and sometimes surprising aspects from a scientific point of view.

At first sight it seems to be unusual and impracticable that sprouts, deprived of a considerable part of their nutriment should begin to develop, and that a plant fit for life, giving a yield of full value should grow out of the sliced grain.

In order to avoid misunderstandings, I have to point out that the ends remaining after having sliced the grain into 4 pieces for milling purposes cannot be used for sowing, contrary to public belief. This is all the less possible, as the average length of a grain of wheat is 6 to 6.5 mm, while the sperm lies at its back side in a length of about 2 mm. When slicing the grain into 4 pieces, the outer blade cuts across the sperm, as the 85 : 15 % proportion of the middle and end parts can be achieved only this way.

For sowing purposes we divide the wheat of minor weight (pro 1000 grains) into two halves as indicated in Fig. 4 by I. The wheat of bigger weight (pro 1000 grains) is sliced with two knives, applying "grain division", in the way indicated by II. At the latter process we cut out a slice of the middle part of the grain, thick enough not to hurt the grain. The slice gained thus way and making out about 15 to 20% of the grain mass, can be ground equally to the middle products of the slicing carried out for milling purposes.

In case of division into three parts the wheat contains sperm and staple ends in a proportion of 50%, as the grains cannot be placed into the pockets of the slicing machine in the direction of sperm ends. Before sowing these have to be sorted by means of a special equipment. For this purpose we have used a separator, operating on the basis of form and specific weight differences and effectuating the sorting with wind stream, shaking and collision, provided with an adjustable table. We are enabled to use the separator by the difference of specific weight at the end parts, as the staple end is always tapered. Sorting is promoted also by the elasticity of the sperm end when colliding against the bars of the sorting equipment due to its compact hide, whereas elasticity of the staple end is considerably diminished by its hairs.

Besides field seed we have carried out preliminary laboratory tests. I should like to comment on the results of some tests as follows.

Data of the thousand piece weight have been most interesting both with autumn and spring wheats. The measuring average of thousand pieces halved sperm and staple parts, though reiterated several times, did not show differences in length, yet thousand piece weight of the sperm ends has been considerably bigger than half of the thousand grain weight of the original grains, while weight of the staple ends decreased. This explains the difference in the weight

Schedule No. 4

Thousand grains weight of the unbroken wheat and thousand pieces weight of the sliced wheat

Serial number (1)	Type (2)	Thousand grain weight g. whole wheat (3)	Thousand piece weight	
			(4) halved wheat	(5) wheat reduced by three
1	Winter	40.4	22.3	19.2
2	,,	38.5	22.1	18.8
3	,,	37.0	21.9	18.2
4	,,	36.5	21.7	17.7
5	Spring	33.7	19.3	16.4
6	,,	33.4	18.8	16.0

percentage rate of sperm and staple ends of similar length won by slicing according to Schedule No. 1.

In Schedule No. 4 I have drawn up the thousand piece weight of sheats of different thousand grain weight as well as the thousand piece weight of sperm ends won by the slicing of such wheats.

We have also tested the water absorbing capacity of whole and sliced wheat of similar basic water content. During a 10 to 500 min. steeping period we have got the values figuring in Schedule No. 5.

Increase of the water content during a 10 to 500 min. steeping period is demonstratively illustrated by Fig. No. 1.

In the diagram it is apparent that water content of the whole grain shows a linear elevation in proportion with the steeping period, while in the case of sliced wheat water content rises rapidly at the beginning of the steeping, and the curve follows the direction of the whole grain water absorption graph only after 250 to 270 min., in about 150—170% higher values. The 45—50% water content necessary to start sprouting is obtained in the case of sliced wheat in about 200—210 min., the same process requiring about 500—550 min. in the case of whole grain. The quality of durum wheat exerts, of course, a certain influence on this

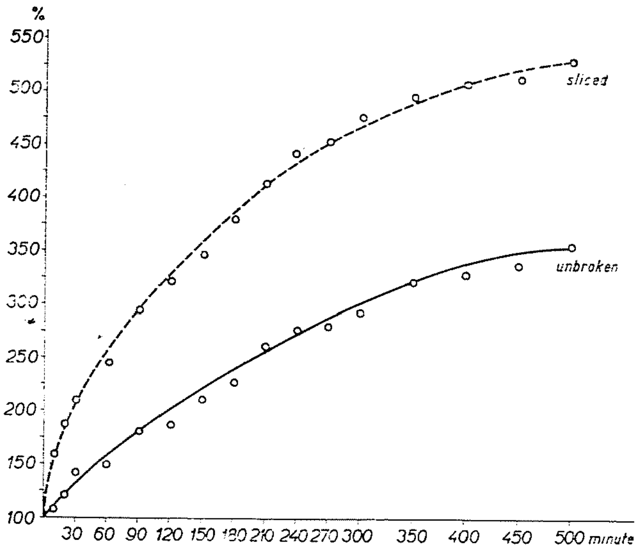


Fig. 1. Diagram of water absorption

Schedule No. 5
Water absorption of the unbroken and sliced wheat

(1) Wetting time in minutes	Unbroken wheat (2) Water content absolute value	Unbroken wheat (3) %	Sliced wheat (4) Water content absolute value	Sliced wheat (5) %
0	11.7	100	11.7	100
10	12.6	107.7	18.5	158.1
20	14.1	120.5	21.8	186.4
30	15.8	135.1	24.4	208.6
60	17.5	149.6	28.7	245.3
90	21.2	181.2	34.0	290.6
120	22.1	188.9	37.5	320.5
150	24.8	212.0	40.5	346.2
180	26.6	227.3	44.4	379.5
210	30.65	262.0	48.38	413.5
240	32.26	275.7	51.86	443.2
270	32.80	280.3	53.15	454.3
300	34.30	293.2	55.70	476.1
350	37.75	322.6	57.98	495.5
400	38.60	330.0	59.60	509.4
450	39.69	339.2	60.12	513.8
500	41.74	356.7	62.19	531.5

period, our experiences show, however, in every case, that the optimum wateı absorption of sliced grain compared to whole grain of similar inner structure takes about 60% shorter time. The rapid water absorption observed with sliced grains at the beginning of steeping is of primordial importance, since these increase their water content to 208% within 30 minutes, while whole grains reach a similar value no sooner than 150 minutes.

This circumstance contributes considerably to earlier swelling and, subsequently, to earlier sprouting of the grains. More rapid water absorption results from the section surface, through which water can contact directly a part of the endosperm. According to our experiments this feature holds not only in laboratory relations, but it has great significance also in the promotion of seed sprouting. It realizes the better exploitation of ground water content and quickens the beginning and furthers the more vigorous enactment of amylo-proteolytic, enzymatic processes previous to sprouting.

In our sprouting tests the sprouting vigour of sliced grains proved to be definitely superior to that of whole grains, with all

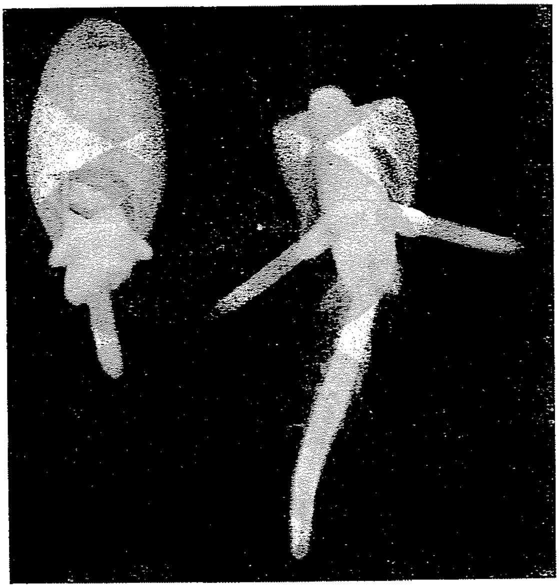


Photo 6. Sprouting wheat grains

Photo 7. Sprouting rye grains

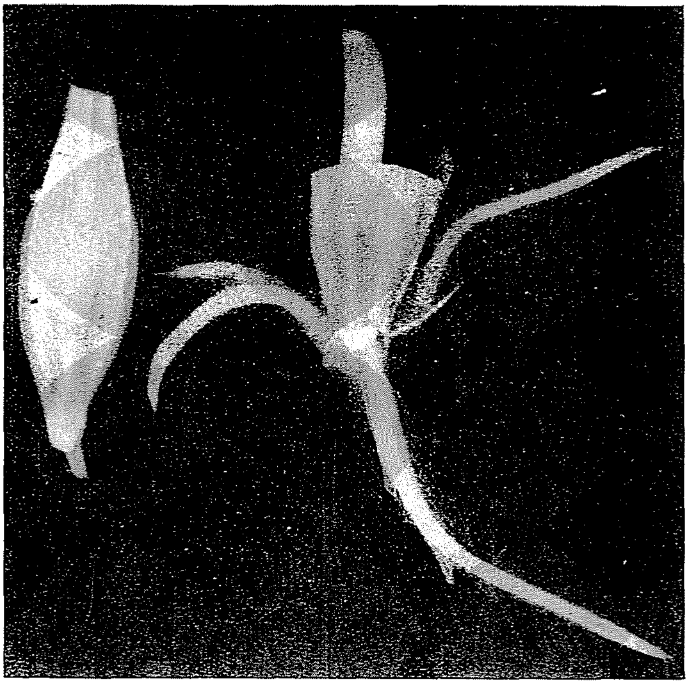


Photo 8. Sprouting barley grains

cereals. This can be accounted for by the favourable water absorbing capacity as stated above.

The difference between the sprouting vigour of sliced and whole grains is illustrated in Figures 6, 7 and 8.

We have begun with the sprouting of sliced and whole grains at the same time with all cereals at the optimum temperature of 25° C. On sliced grains vigorous development of the tap root as well as of the adventitious roots and the sperm husk is obvious in 24 hours. On the other hand, appearence of the sperm husk is hardly noticeable on whole grains, and only initial development of the tap root has been observed. The difference is most apparent on barley, where the sperm husks of the halved grain need not follow the full length of the corn under the skin, they may easily get out into the open air through the section surface. The difference between primary roots and the developing energy of the sprout is still more conspicuous on the 2-days-old sprouts portrayed in the photos. Diagrams of Fig. 2 illustrate the difference between the sprouting energy of halved and whole grains in conformity with certain days of the sprouting.

Our sand culture sprouting tests show in all cases that it is not only the sprouting vigour of the sliced grains that proves to be outstanding, but also roots are stronger and springs are longer at the beginning. The plants of control whole grain reached those coming from sliced grains in respect of length growing only on the 4th and 6th day, hence overtaking the former, as the roots could not take up nutriment from the siliceous sand, annealed and washed out, and the springs had to fall back solely on the nutriment available from the kernel. At seed-pan tests and in the field the situation is quite different, as the roots developing earlier and more vigorously can take up nutriment from the ground and have the

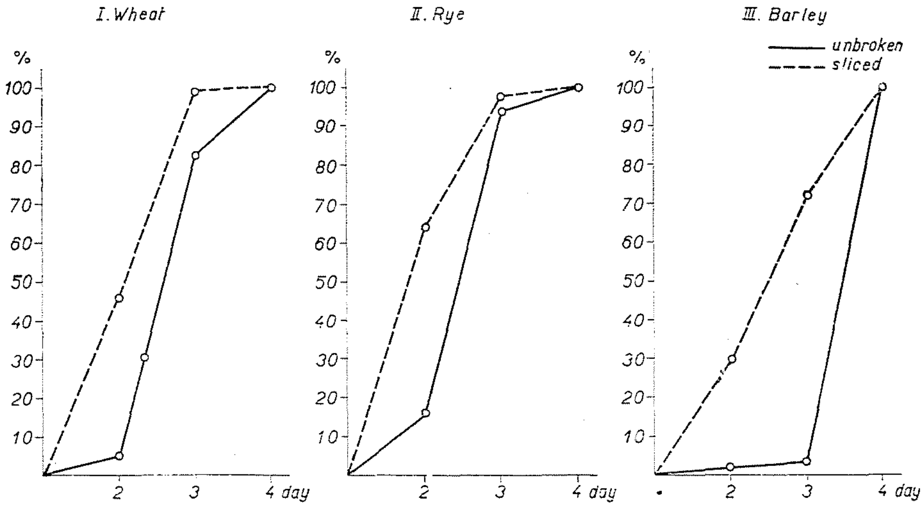


Fig. 2. Diagram of the sprouting energy of wheat, rye and barley

possibility to make use of the initial advantages of sprouting.

From several sides the suggestion was made that in case of wet seed-dressing the kernel would partly or entirely dissolve, what would lead to further diminishing of the already modest quantity of nutriment available for the sprout, while through the section surface the possibilities of infection increase compared to whole grains. According to our experience, there is no cause for anxiety in this respect, in view of the fact that in most cases we have intentionally used wet dressing, in order to utilize the favourable conditions of water absorption as mentioned above, and to obtain better results by getting the absorbed material reach the endosperm instead of only the surface of the husk.

The floury kernel has not been dissolved, on the contrary, the section surface allows the replacement of nutriment, *i. e.* enrichment by dressing solution or in other ways, what we have tried to utilize, too.

We have been carrying out our field tests for years, in the course of the economical years of 1957—58 and 1958—59 partly in form of parcel experiments, partly on a full plant scale, in many parts of the country. The parcel tests have been effected on the basis of accidental arrangement with five-fold reiteration, applying an evaluation based on analysis of variance. It was our endeavour to select the most kinds of ground in the greatest variety, from loose sand ground to heavy ground inclined towards alkalinity. In our full plant scale experiments we have sown equal areas in each case with "Bánkúti 1201" wheat, applying sliced, and for control, whole seed. The preparation of the soil, artificial fertilizing, sowing time and number of sown sperms pro meter, etc. *i. e.* all agrotechnical factors have been equally ensured for halved and control seed. Data of our full plant tests performed in seven estates in the years 1958—59, on 88 cadastral yokes, figure in Schedule No. 6.

Depending on the sperm content of the sorted end parts, sowing an equal number of sperms as with the control seed, about 35—40% of sliced wheat can be saved. In our seeds halved wheat came up 1 or 2 days sooner in every case. I have to point out that at our autumn seeds in 1958, in an area of about 20 cadastral yokes, sliced wheat has sprung up about 12 days sooner than

Schedule No. 6.

Yields of full plant scale experiments with sliced wheat in 1958—59.

Ser. No.	Place of sowing	Time of sowing	Soil	Previous sown	Sown: Material	Sown: Space cad. yoke	Sown: Quantity kg/c/yoke	Harvest q/c/y	Sowing: Surplus harvest	Sowing: From sowing	Sowing: Total
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1.	Érd	X. 20	Medium bond adobe	Tobacco	Unsliced	0.5	120	20.04	—	—	—
					Sliced	0.5	80	20.48	44	40	84
2.	Kistápé	X. 16— —18	Brown sand	Tobacco	I. Unsliced	1	110	11.89	—	—	—
					Sliced	1	73	12.07	18	37	55
					II. Unsliced	5	110	10.97	—	—	—
					Sliced	5	73	12.92	195	37	232
3.	Háromrózsa	X. 10	Clay adobe	Peas	Unsliced	10	120	14.79	—	—	—
					Sliced	10	80	15.81	102	40	142
4.	Kartal*	X. 10	Clay adobe	Peas	Unsliced	5	110	14.84	5	—	—
					Sliced	5	68	14.79	—	42	37
5.	Monor	X. 22	Brown sand	Mais	Unsliced	0.5	120	14.00	—	—	—
					Sliced	0,5	78	15.04	104	42	146

* In consequence of faulty adjustment of the sowing machine the number of sliced germ sown was less by 10% than that of the unsliced one.

whole seed. We have found the explanation of this in the fact, that because of the lack of precipitation that autumn, the slight moisture of the soil could be utilized much better by the sliced seed, in accordance with the aforesaid.

During the vegetative period we have found most interesting differences in the development of plants coming from whole and halved grains. These are the following:

In the first stage of growth a vigorous development can be observed in the roots of sliced seed, to the detriment of the overground part. Primary roots are richer and longer than in the case of the control plants. That is to say, the plant, wounded artificially, was compelled to exploit the nutriments of the soil to the greatest possible extent by means of stronger roots. This is all the more important, as the nutriment available from the grain ensures the development of the plant for a considerably shorter period than in the case of a whole grain, though here we find undoubtedly a super-storage of nutriment.

Stronger roots are significantly shown also in the tufted roots formed after the root change, and above longer roots there is also a characteristic "second level" which performs the duty of thick, strong supporting roots. This feature contributes greatly to the increase of resistance against lodging and is rarely noticeable on the plants of whole grains.

The stooling of sliced wheat was less intensive than that of whole grain plants, consequently at seeds of equal sperm number the mass of plants seemed to be scanty till the putting forth of stems.

To examine the stooling we have effected one-seed sowing in 20 × 20 cm net with

Photo 9. Plants grown of unbroken and sliced wheat seeds

six-fold repetition. Though at normal sowing density breeding conditions are different, also this experiment has clearly proved the difference in stooling inclination. Such a wide foster-soil facilitates namely development of the largest number of shoots. Our experiments gave the following stooling results in the average of 500—500 plants:

Treatment	Number of shoots 1	2	3	4	5	6	Average
Whole	5.7	5.6	4.3	5.8	5.4	4.9	5.3
Sliced	3.5	2.9	3.5	3.4	3.2	2.6	3.2

According to our observations in the case of sowing at wheat row space, stooling of the halved seed is about 1.5, while that of whole seed amounts to about 2.5—3. As a result of this feature, having sown equal number of sperms, the mass of halved-grain plants seems to be poorer than that of the control-plants after stooling. Poor stooling has to be considered as a definite advantage, as in this way the nutriment taken up by stronger roots can be utilized by the main ear. Stooling and putting forth stems took place at the same time at both kinds of

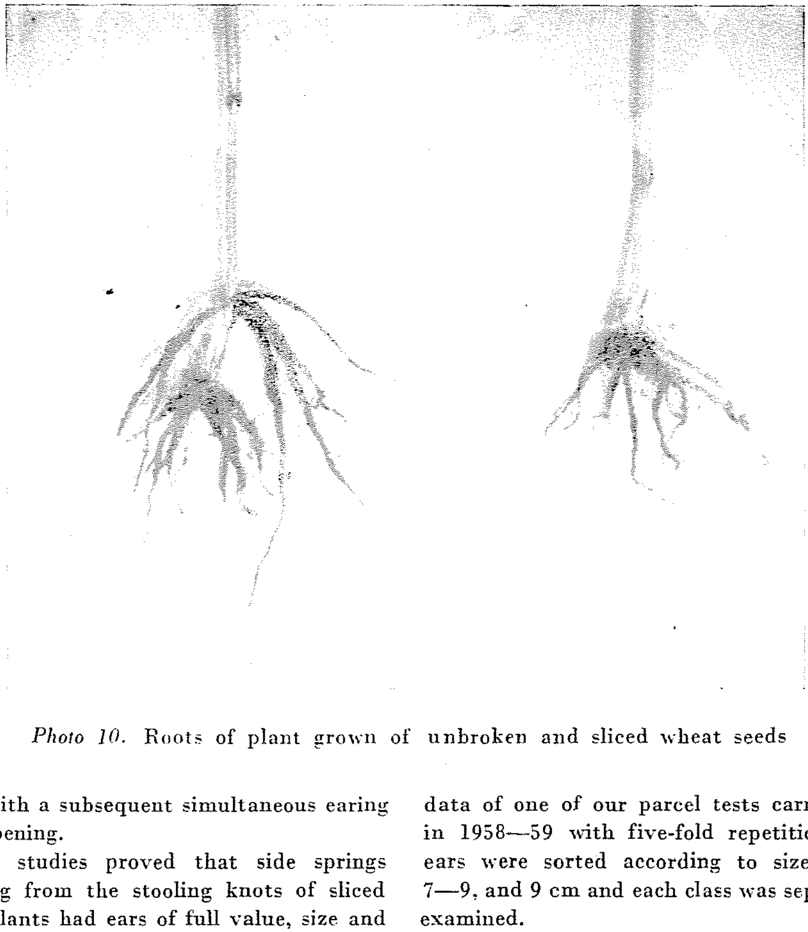


Photo 10. Roots of plant grown of unbroken and sliced wheat seeds

seed, with a subsequent simultaneous earing and ripening.

Our studies proved that side springs shooting from the stooling knots of sliced grain plants had ears of full value, size and number of corns, riping simultaneously with the main ear. On the other hand, a part of the side springs of the whole seed with rich stooling had no ears at all, and the ears of such springs could in the majority of cases not be considered of full value. The cause of this lies in the fact that the stronger roots, penetrating deeper could provide the 1—3 springs coming from halved grain with the nutriment necessary for full development and ripening of same. In the case of more vigorous stooling the roots could not supply 3, 5 or eventually more shoots with the necessary nutriment, and so even the ears of the main spring were smaller, with a reduced number of corns.

Schedule No. 7 contains experimental data of one of our parcel tests carried out in 1958—59 with five-fold repetition. The ears were sorted according to sizes 0—7, 7—9, and 9 cm and each class was separately examined.

The short summing up of the testing results is as follows: In the class of the greatest length, 34.2% was made up by whole grain ears, whereas the number of sliced grain ears amounted to 48.5%. Examining the weight of corns, the difference is still more striking, the proportion of control seed ears and sliced seed ears being 52.7 to 70%. From bigger ears we get bigger corns, shown also by the thousand corn weight, also within the material of equal treatment. For example:

36.7—41.4—45.4 grams at whole seed corns, and

37.5—42.2—47.1 grams at halved grains.

Apart from that, the weight of corns got from ears of the same category was

Schedule No. 7.

Evaluation of the results of experiments with winter wheat sowing in 1958—59

Characteristics	Spike length in cm							
	unsliced				sliced			
	0—7	7—9	9—12	Total	0—7	7—9	9—12	Total
Number of spikes .... pc	114	150	137	401	76	97	163	336
Number of spikes .... %	28.4	37.4	34.2	100	22.6	28.9	48.5	100
Weight of grains .... g	43	125	188	356	31	88	276	395
Weight of grains .... %	12.1	35.2	52.7	100	7.7	22.3	70	100
Number of grains .... pc	1171	3022	4144	8337	827	2084	5855	8766
Number of grains .... %	14.1	36.3	49.6	100	9.4	23.8	66.8	100
Numb. of gr. in 1 spike .... pc	10.2	20.2	30.2	20.8	10.9	215	35.9	26.1
Thousand grain weight .... g	36.7	41.4	45.4	42.7	37.5	42.2	47.1	45.1
Hectolitre weight .... kg/hl	79.2	80.50	80.50	—	79.35	80.50	81.—	—
Gluten wet .... %	42.19	41.72	41.50	—	42.60	42.58	42.48	—
Ash % in dry material	1.700	1.667	1.618	½	1.676	1.618	1.616	—
Starch in dry material .... %	61.10	63.01	64.43	—	59.32	66.78	67.02	—
Protein .... %	16.70	16.10	15.56	—	16.70	15.18	15.56	—

always more favourable in the case of sliced material, for instance in the 9—12 cm class 45,4 grams (whole) and 47.1 grams (halved).

It is observable that though the number of ears is less at the sliced material coming from the same territory unit (336 compared to 401 in case of whole grain seed), nevertheless the weight of corns turns out to be more advantageous with sliced seed (395 grams to 356 grams).

Explanation: Number of the big ears is greater, number of corns equally (26.1—20.8) and the thousand grain weight is bigger. These values resulted in surplus harvest even in case of a more reduced number of ears. At further seeds it is indispensable to vary the number of sperms, under consideration of the stooling inclination.

The difference is still more interestingly emphasized in Schedule No. 8, where we have assorted the ears belonging to class 9—12 cm also according to sizes 9—10, 10—11 and 11—12 cm. The category of greatest length comprised about 29% of sliced material and 8% of the whole one. Similarly to the data of Schedule No. 7, this had a favourable effect on corn weight (34.1% and 10.1% resp.), the number of corns in one ear (41.0 and 37.0 resp.), and the thousand grain weight (47.1 and 46.7 grams, resp.).

As final result, on the basis of Schedules 7 and 8 the following increases can be registered in liced material: in thousand grain weight about 2.5 grams surplus, in the average number of corns pro ear about 5 corns surplus, consequently, the harvest gained from the same territory has also increased.

In bigger corns the proportion of the kernel and the husk is also more favourable, resulting in a reduced ash content. As far as ash content counted for the dry material is concerned, there is no significant difference in starch and protein content. Results always showed, not only in the case outlined here, that there is no perceptible deterioration in the quality of sliced seed harvest, while its quantity showed undeniable increase in consequence of longer ears, greater number of corns and bigger thousand grain weight. Achievements of our parcel tests have been confirmed by field experiments.

Thrashing is finished at five places by now from among seven estates where experiments have been carried out, and in all cases there proved to be a surplus in harvest, with sliced corn. This, together with the quantity of saved seed-corn, makes out a considerable lot pro cad. yoke. Even at Kartal, where the number of sown sperms was about 10% less in the case of sliced material, savings of 37 kg have come forward. The 5 kg shortage in the yield falls anyway within the margin of error, and so the yields are to be considered as unaltered. In case of equally numbered sperms there would have been a surplus also here.

It is especially worth mentioning that at our sliced wheat seed in Kistápé, the surplus in result has been 323 kg pro cad. yoke in the second year, with a harvest surplus of 195 kg/cad. yoke. This fact supports our experiences, according to which repeated splitting of the grains can still improve our achievements by transmittal of the introduced features.

I have to draw attention also to the differences shown in the strength of stem. Comparing average results of the serial measurements we have found in every case that the bending strength of plants coming from sliced grains surpasses considerably that of control plants at equal stem length and thickness. We have carried out our tests in this respect from the beginning of gleaning by stem links, examining 10 cm long stem parts between two knots. After taking out the plant from the soil, we have immediately measured the bending strength and the breaking point of each stem part, and by means of a drawing equipment we have drawn up the graphs of all stem parts of a wheat stalk on one page. Thus we have got the differences shown in the bending strength of several stem parts of the same wheat stalk. Fig. 3 demonstrates the curves corresponding to the average bending strength of sliced grain and control plants respectively, measured at harvest time.

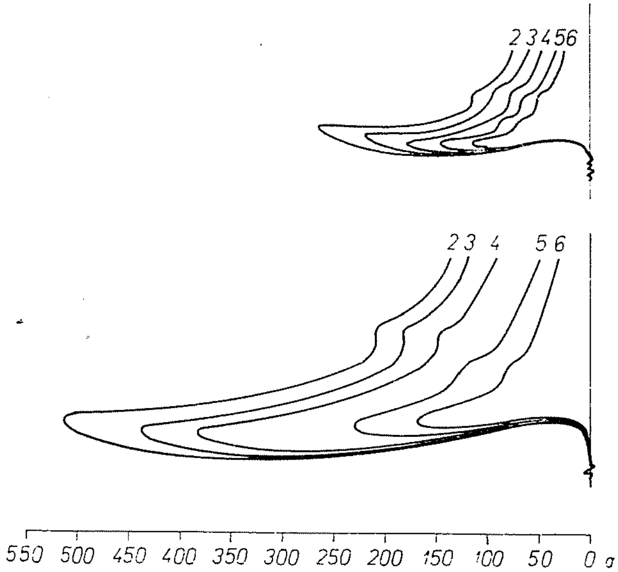


Fig. 3. Diagram of the flexure strength of the plants grown of unbroken and sliced wheat

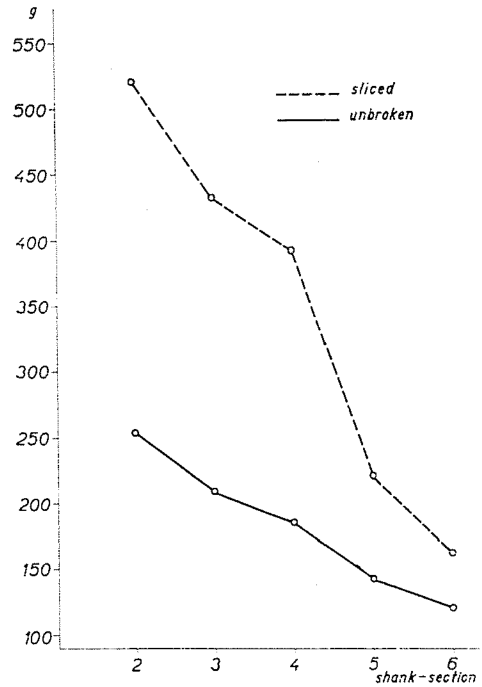


Fig. 4. Diagram of the straw-strength of unbroken and sliced wheats per shank-sections

The values got during the harvest of July 19th, 1959, are indicated also by a diagram on Fig. 4.

The first stem part could not be examined, as it became stringy and its length was hardly 1—2 cm. From the point of view of lodging the stem part of decisive importance is the second one, data of which, together with those of the other parts have been duly registered. The second stem part proved to be the strongest, strength of the stalk diminishing gradually upwards. This regularity has been valid for sliced grain and control plants as well. Numerical data, however, proved essential differences. Bending strength of the sliced grain plants has, on the whole, surpassed that of the control plants by about 100%. This fact was justified not only by measurements, but also by actual practice, when in consequence of two thunderstorms the control plants lodged and a considerable part of same remained lying on the earth, whereas the plants of sliced grains were saved, that is to say, where they were bent to a small extent in a day they stood up again.

We attach extraordinary importance to the above feature, considering the development of combine wheats and the possibility of automatic harvesting.

These have been the achievements registered in the course of our experiments.

We have, of course, not ended our researches and are going on with experiments on enlarged sowing areas. Apart from that we are aiming at settling several questions as to artificial fertilizing, sowing density, etc.

The results obtained up to now are, however, significant enough in themselves, taking into consideration that essential savings in seed-crops and the increase of straw-strength can be booked as economical successes, even supposing that the yield remains unaltered. Should also our further experiments result in a significant surplus of yield, this will only raise the value of sliced seed.

Summary

The grain slicing machine system Rajkai discloses unknown possibilities in the milling industry and in agriculture, based on the fact that grains can be split with the minimum effort perpendicularly to their longitudinal axis. In the milling industry it is most efficient to cut the grain into 4 or more pieces, when we get "middle parts" of small husk content, making out 85% of the grain weight and "end parts" of bigger husk content, amounting to 15%. The two kinds of products are automatically sorted by the machine. The middle parts furnish, at higher extraction rate than before, fine flour of low ash content. End parts can be utilized also separately for the production of enriched baby-food or sperm-oil. Slicing shortens the process of grinding technology, and results in saving considerable cylinder length, boulter surface and coarse meal cleaning width.

For sowing purposes wheat will be sliced into two or three pieces. Sperm and staple ends are sorted by means of a separator, by the help of differences in size and specific weight. In our sowing experiments we have applied similar agrotechnics both with whole and sliced grains. In case of sowing equal number of sperms pro meter, about 60—65% of the quantity to be sown of whole grains is sufficient if sliced grains are applied, depending on the size and cleanness of the sperm ends. Wet and dry seed-dressing is equally applicable.

Water-absorptive capacity of sliced wheat is much better than that of the whole grain. Carbohydratic and enzymatic processes start sooner and more vigorously. Sprouting vigour is bigger, springing is faster. Roots are longer during the whole period of development. The extent of stooling is somewhat reduced, side ears are fewer. At the same compactness ears are longer, number of corns increases. Corn harvest gained from territory units is bigger. Thousand grain weight rises, hectolitre weight shows a slight fall. No change has been observed in the endosperm, values of ash, gluten, starch and protein are unaltered.

Up to now there was considerable difference in the stalk strength of plants of similar stem length and thickness, comparing sliced and whole grains of the same species (B. 1201).

THE NEW PRODUCTS OF HUNGARIAN SURVEYING INSTRUMENT INDUSTRY

By

F. PUSZTAY

The production of surveying instruments, in our country, has a past of several decades. The less accurate instruments, having graduated silver circles, made by the Nándor Süss Precisionmechanical Works, were known at home as well as in other countries, moreover before World War II there appeared in the market their theodolites with glass circles

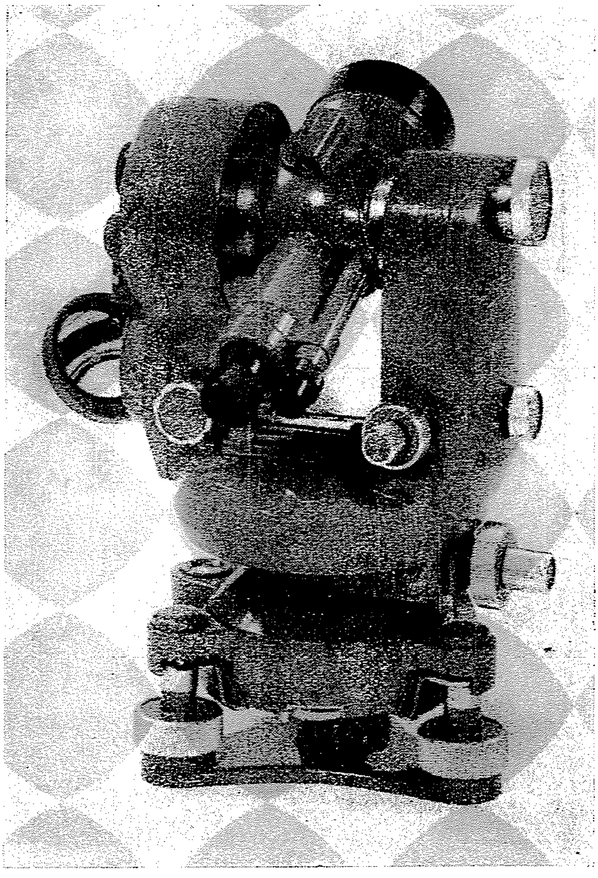


Fig. 1

for more precise measuring purposes. These were, however, for the most part designed by Zeiss Works.

Quite independent designing work begun no sooner than the end of World War II, after the technology of glass circles had been solved.

In general, our purpose was the improving of constructions, considering the increasing of angle measurement accuracy. Increasing the precision of angle measuring can be done by applying an instrument of lower degree of accuracy as well by increasing the number of readings. The multiple readings at the same time make measurements slow. The rapid industrial development of nowadays, however, demands a swift supply of informations, so our purposes are, decreasing the time required for the measurements, and simultaneously increasing the precision of our instruments. That was why the modern surveying instruments became necessary.

The first quite new and up-to-date instrument, the plane table, type „MF" came out from the Hungarian Optical Works, during the years 1952—53. It was followed by the engineer's leveller type Ni—B1 and soon after the theodolites Te—D1 and 17 KS. Now the theodolites Te—B1 and Te—C1 are to be manufactured.

Now we give a detailed specification and the fields of application for the one second direct reading theodolite, type Te—B1 (Figs. 1, 2, 3), its constructional characteristics, and the results of measurements made with the instrument.

Specification

Telescope

Magnification	30-fold
Aperture of objective	45 mm
Field of view	1° 20′
Total length	174 mm
Stadia ratio	100
Addition constant	0
The greatest vertical angle, can be measured in 1st or 2nd positions of telescope	53°
Shortest focusing distance	
with telescope	2 m
with optical sighting device	at will

Horizontal circle

Diameter of circle graduation	93 mm
Graduation interval	20ᶜ (20′)
Magnification of reading microscope	30-fold

Vertical circle

Diameter of circle graduation	60 mm
Graduation interval	20ᶜ (20′)
Magnification of reading microscope	45-fold

Optical micrometer for reading both circles

Graduation interval	2ᶜᶜ (1″)

Levels (sensitivity pro 2 mm)

Plate level	20″
Altitude level	20″
Circular level	6″
Striding level (upon request)	10″
Horrebow level (upon request)	10″

Optical plummet

Field of view	6°
Focusing distance	50 cm —
Magnification	3-fold

Dimensions and weights

Height of instrument	230—239 mm
Height of instrument up to the horizontal axis	190—199 mm
Weight of instrument	5.5 kg
Dimensions of instrument case	17×20.5×35cm
Weight of instrument case	3.5 kg
Lenght of tripod (telescoped and extended)	98 and 155 cm
Weight of tripod (with cap and shoulder belt)	6.2 kg

Fields of application

The instrument — with a great number of its accessories — can be applied for many purposes.

Its accuracy of circle reading makes it applicable for triangulation of the 3rd and sometimes even of the 2nd order. Its closing error in the case of 6—8 directions is under 2.5″. The mean error of a direction measured in both positions of the telescope is less than ±1.2″. With double-image wedge adapter and a horizontal staff of special design, the instrument can be applied to distance measuring of lower precision having an error under ±2 cm at a distance of 100 meters. Exact distance measuring can be accomplished with a 2 m invar subtense bar. Then the error is less than ±1 cm at a range of 100 m. The instrument is especially fit for precision traversing, because its levelling screws of special design make it possible to interchange the instrument, the subtense bar, and the targets, their centres remaining within 0,02 mm, without altering the levelled state of the accessories put on.

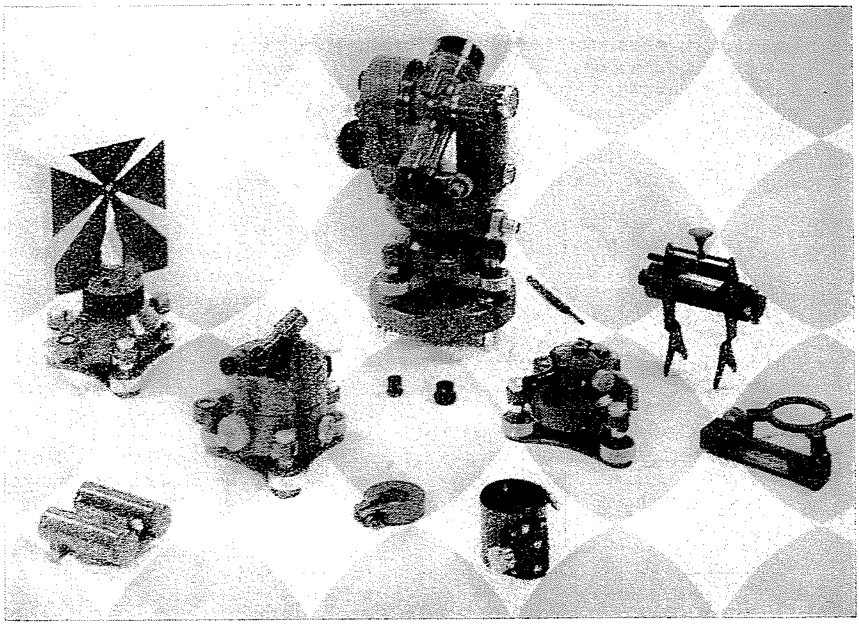


Fig. 2

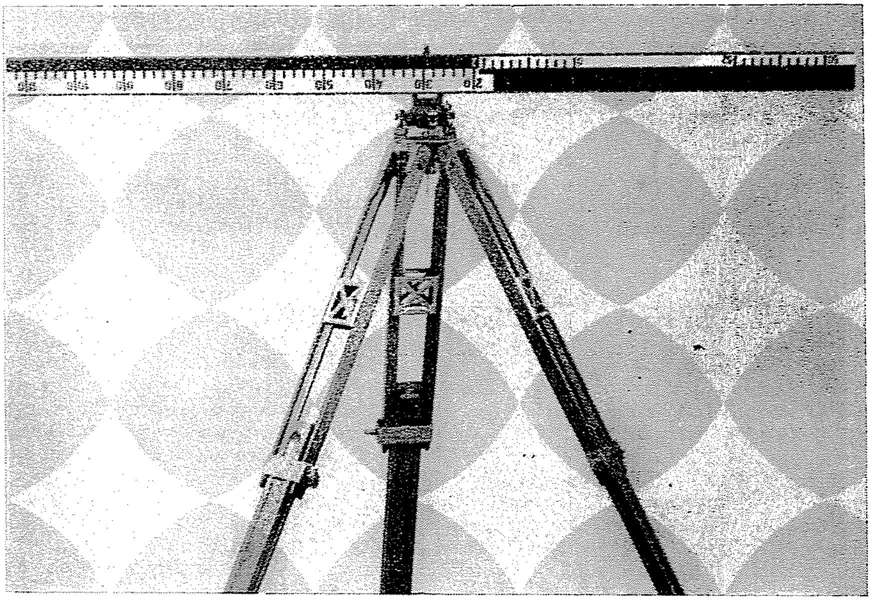


Fig. 3

In addition, the instrument can be used for measurements of lower precision in astronomy, too, as there is a Horrebow level and a striding level among its accessories.

The equipment is completed by a prismatic compass and an optical plummet for sighting above and below. For measurements in mines, the instrument, the targets, and the subtense bar are equipped with electric batteries.

Characteristics of mechanical design

An important requirement for rapid measuring is the functional arrangement of operating screws. For that purpose, both horizontal and vertical fixing and slow motion screws are coaxial, so the observer can easily handle them.

All the hand manipulated setting screws of the instrument work with automatic elimination of wear. The instrument can be

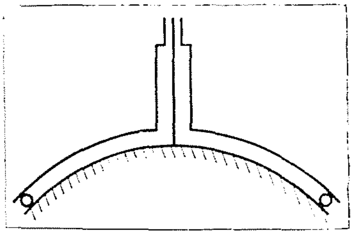


Fig. 4

taken off from its levelling screws, and in any position its eccentricity remains less than 0.02 mm.

Its centring and levelling base is of novel type; clamping automatically, it makes quite impossible to fall the instrument down because of absentmindedness when happening to transport it on the tripod. The theodolite can be taken off from its levelling screws by turning a button. This accomplishment is an improvement of the former systems, the guides having been placed not on the bedplate, but on the instrument itself, the levelling screws standing with their points upwards. The releasing button can be turned against a spring and after placing the theodolite back (to the levelling screws) it returns to the original position, automatically fixing the instrument.

The system of its vertical axis (Fig. 4) is patented: the weight of the theodolite is transmitted to the standing part by balls put between two concentric spherical surfaces. Both spheres can be polished accurately by optical methods. Tilting of the axis is prevented by a journal bearing.

The axis, still in the prototype, was subsided to multiple examinations. The measurements were carried out using two levels, each with a sensitiveness of 1.2″ pro 2 mm graduation. The instrument was turned around five times to the left and to the right, reading the levels at every 45° angle. The values were obtained as the arithmetical mean of the readings on the four ends of the bubbles. The values, observed, when turning to one side, can be seen on the diagram in Fig. 5, where the deviation of the levels is plotted against the turning angle of the axis. From the numerical values, mean errors were determined at each stand of reading (Table I). Following from that, the average value of mean error does not exceed $\pm 0.846''$. The maximal value of tilting was 3.81″, occurring at 0 degrees. Measurements were made between temperature limits of $-10°$ C and $+40°$ C and it was found, that the average value of mean error did not alter even on the two temperature limits more than $\pm 10\%$.

Table I

0°	$\pm 1.316''$
45°	$\pm 0.899''$
90°	$\pm 0.209''$
135°	$\pm 1.124''$
180°	$\pm 0.943''$
225°	$\pm 0.922''$
270°	$\pm 0.131''$
315°	$\pm 0.536''$

Characteristics of optical design

The telescope of the instrument is of the internal focusing type, anallactic, and it is properly protected against dust and moisture. On the reticule of the telescope there are stadia lines both for vertical and horizontal staves. Its sighting device is a small collimator telescope. The circle reading ocular has been placed beside the telescope and there can the horizontal or vertical circle be read in it according to the position of a button. The theodolite gives imaged readings from diametrally opposite places of the circles moving in opposite direction as the circle is rotated. To obtain a reading, the optical micrometer is turned to displace the double lines and set them in a position of coincidence, enabling the observer to read directly to 1″ and estimate reliably to 0.5″. The mean error of coinciding is less than $\pm 0.8''$. The light paths of the theodolite and the circle readings can be seen in Fig. 6.

The circles can be illuminated by a great mirror adjustable to any direction. The instrument is fit for night work too. Then light comes either from an electric torch or in case

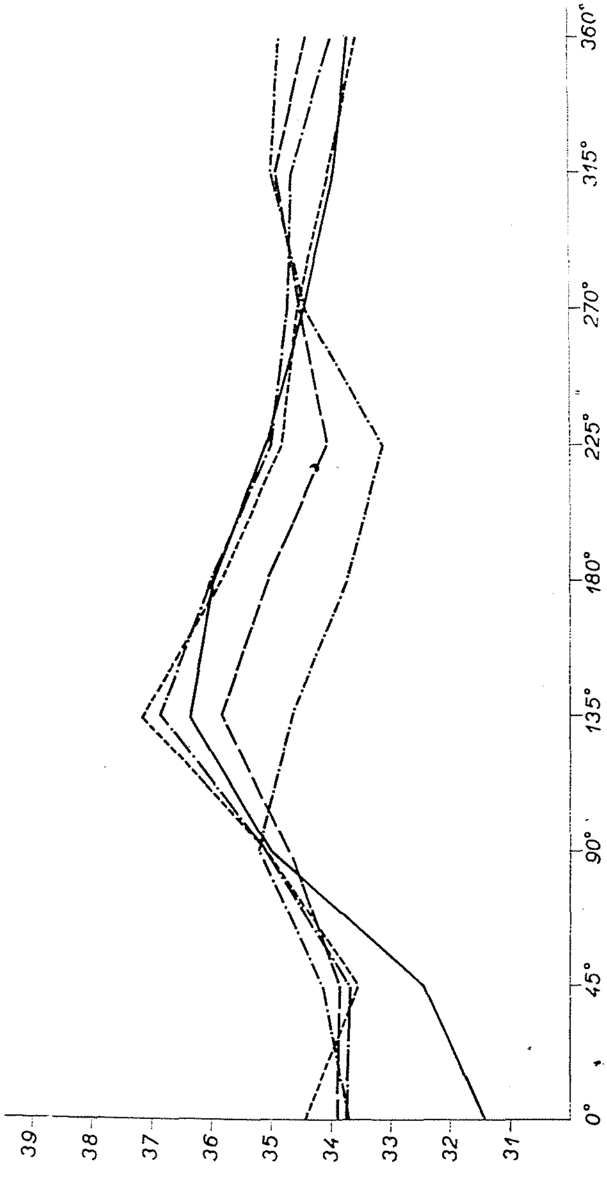


Fig. 5

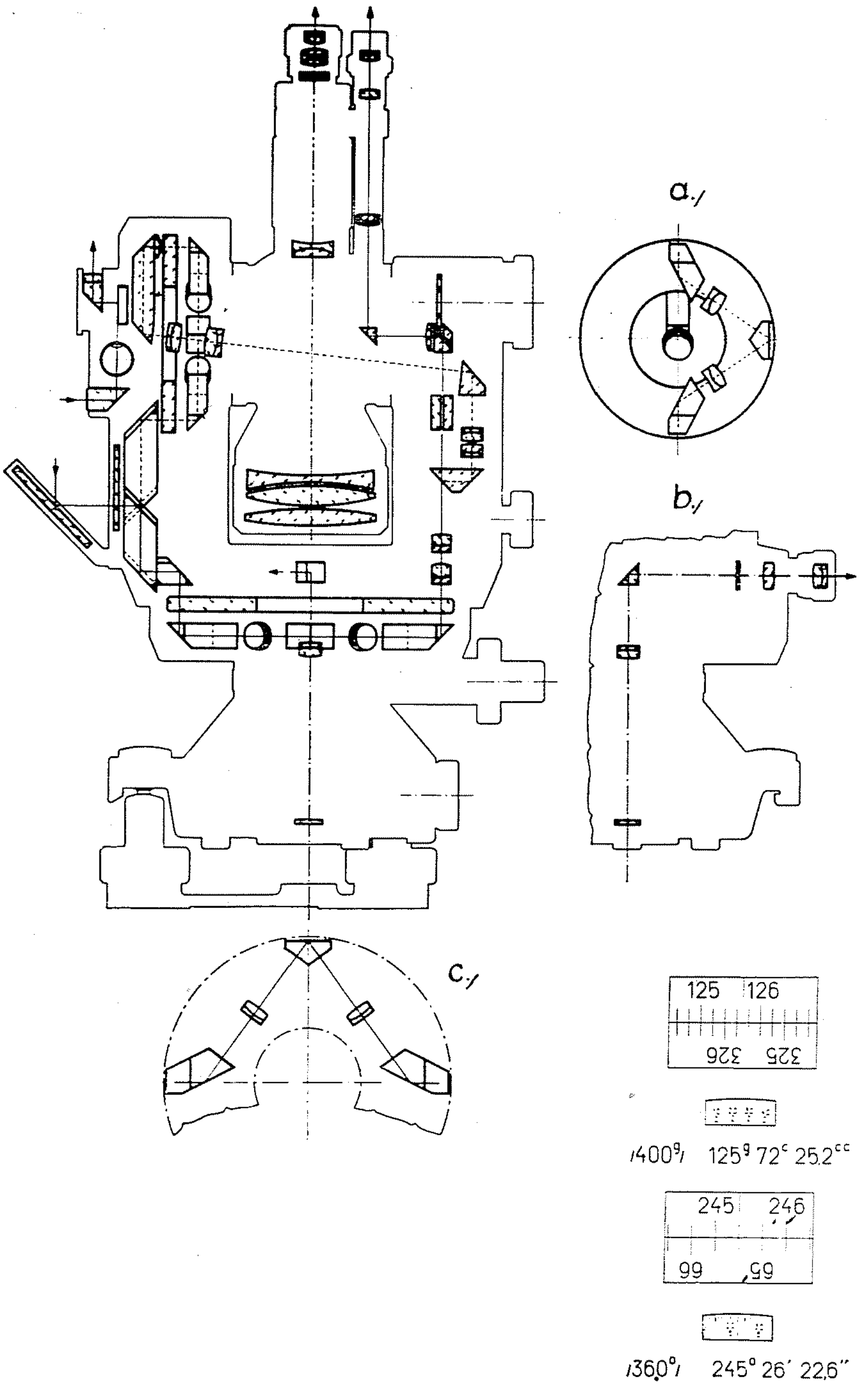


Fig. 6

of measurements claiming much time from an electric lamp wired to a large battery on tripod leg. The theodolite can be centred by a built-in optical plummet.

Stativ

The stativ of the instrument is an especially rigid tripod in regard for the high accuracy required in its angle reading. The tripods of the modern theodolites made of circular hard wood bars are well-known. The stability of these stativs is not sufficient in all cases. For the stativ of this instrument, the designer has chosen a bar having T-shaped cross-section, the rigidity of which is about 50% greater — without increasing its weight. The easiness of turning the tripod legs in their bearings is adjustable by a hand knob in each leg. The instrument is transportable in a metal case having a comfortable handle. To prevent the deformation of the axis system and ball tracks, the axis is automatically arrested when placed in the case.

Universal Theodolite Te—C1

General description

As a part of our program of developing new surveying instruments, the universal theodolite Te—C1 (Fig. 1) is to be manufactured. Its construction is resembling to that of the Te—D1 (of 6 seconds direct reading). Its accuracy does not reach that of the instrument Te—B1 — in spite of its telescope having the same magnification and its circles being graduated at 20 minute intervals — because its optical micrometer is graduated to give direct reading to 10 seconds, and to estimate single seconds. This instrument is an intermediate type between the 0.1′ and the 1″ direct reading theodolites. In case measurements when a lower rate of precision is sufficient, it is enough to read the nearest 10 second value directly, but when higher accuracy is needed, single seconds can be reliably estimated. The mean error of pointing remains less than ±2″, therefore the mean error of adjusting a position of coincidence does not exceed ±1.6″, in a series of five measurements.

For this reason, the field of application for this instrument is very broad. It can be well applied for triangulation of the 3rd order already, for precision traversing work and for measurements in mines. It can be economically utilized in any work when only a lower grade of precision is needed, having been designed for the rapid performance of these measurements. The rapidity of manipulating is made possible by the following improvements:

1. The horizontal and vertical circles can be read at the same time through the reading eyepiece.

2. Its fixing and slow motion screws are coaxial.

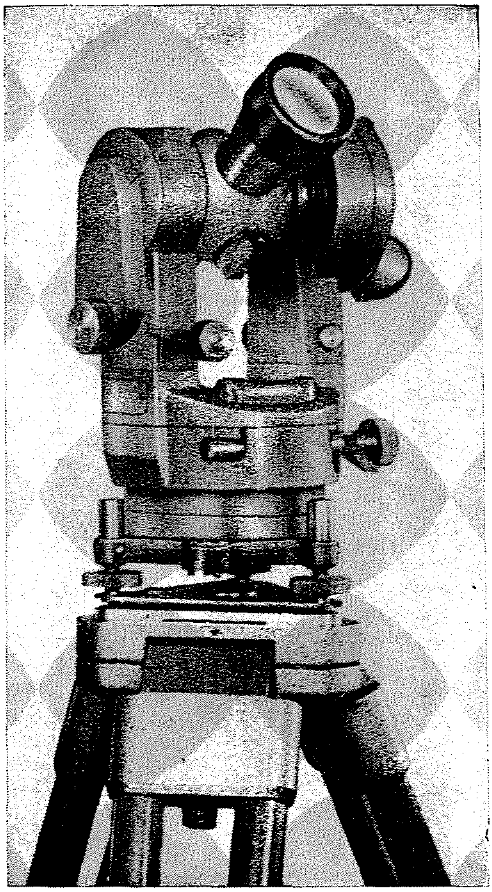


Fig. 1

3. Both fixing screws can be turned by a lever and their end positions are adjustable.

4. Its optical sighting device is a collimator.

5. The slow-motion screws can be operated simultaneously by both hands.

Specification

Telescope

Magnification	30-fold
Aperture of objective	40 mm
Field of view	1° 30′
Total length	175 mm
Stadia ratio	100
Addition constant	0
Shortest focusing distance	2 m

Levels (sensitivity pro 2 mm graduations)

Altitude level	20″
Plate level	30″
Accuracy of setting by coincidence of bubble ends	under 1″
Circular level	7″

Graduated glass circles

Diameter of horizontal circle	84 mm	
Graduation interval	20′	0.2^g
Interval of numbering	1°	1^g
Graduation in micrometer	10″	20^{cc}
Reading by estimation	1″	2^{cc}
Diameter of vertical circle	76 mm	
Graduation interval	20′	0.2^g
Interval of numbering	1°	1^g
Reading through the same micrometer by estimation	1″	2^{cc}
Magnification of reading eyepiece	24-fold	

Measures and weights

Weight of instrument	5.4 kg
Height from bedplate to horizontal axis	200 mm
Length of non-telescopic tripod	1480 mm
Weight of non-telescopic tripod	4.8 kg
Length of telescopic tripod	940 mm
Weight of telescopic tripod	5.1 kg

Extra accessories

Traversing equipment consisting of the following items :
2 tripods (telescopic or non-telescopic)
2 targets in a common metal case
1 illumination equipment
1 special staff for distance measuring or
1 subtense bar
Wooden case with leather shoulder strap.
Prism eyecaps for telescope and circle reader for high angle reading.
Tubular compass.
Prismatic compass.

Characteristics of mechanical design

The horizontal and vertical fixing and slow-motion screws are both coaxial. Force can be applied to fixing screws by turning a lever to an extent of 45 degrees. The power, being vertical, can not alter the position of the telescope already roughly pointed by the sighting device. There is no need for elimination of backlash because of wear at any of the fixing or slow-motion screws.

The instrument can be taken off from the levelling screws or at traversing work it is interchangeable with the target (Fig. 2), the subtense bar, or a horizontal staff of special design (Fig. 3).

The angle-multiplying instrument base, system Tárczy (Fig. 4), is also appliable to this theodolite. This special accessory is particulary suitable for surveying in mines and precise underground traversing.

Using with its special staff (which gives distance reduced to the horizontal) the error of distance measuring is less than 15 cm when measuring 100 meters. Using it with a 2 meter invar subtense bar, the error does not exceed 2 cm in 100 meters.

The axis system of the instrument is partly a ball bearing, partly a journal bearing.

The axial ball bearing sustains the weight of instrument, as for the journal bearing, it ensures the concentricity of alidade. A special new feature of its design is, that the same journal bearing surface guides both the alidade and the glass circle. The axis is of repeating type. The weight supporting balls are selected with special care, difference in size does not exceed 0.2 μ.

Characteristics of optical design

The telescope of the instrument is of anallactic, internal focusing type. The outer surfaces of lenses are coated with reflection reducing films which make for increased luminosity. A small collimator telescope facilitates coarse setting to the object. The optical system of the theodolite and imaged readings through circle reading eyepiece can be seen in Fig. 5.

The vertical and the horizontal circle readings appear at the same time in the field of view of the reading microscope (together with an image of the optical micrometer graduations), giving two images from diametrally opposite points of each circle. In this way the error caused by occasional excentricity

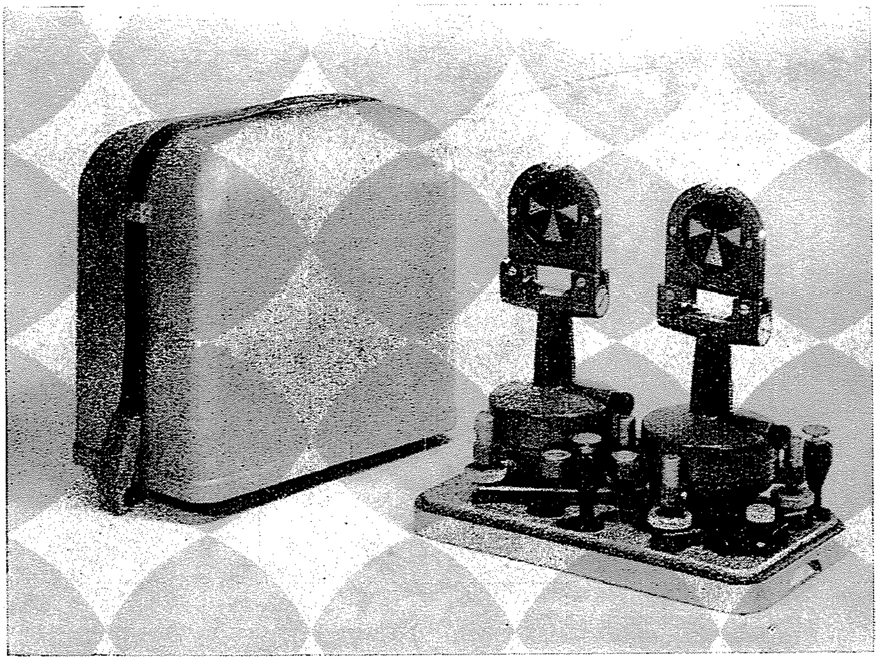


Fig. 2

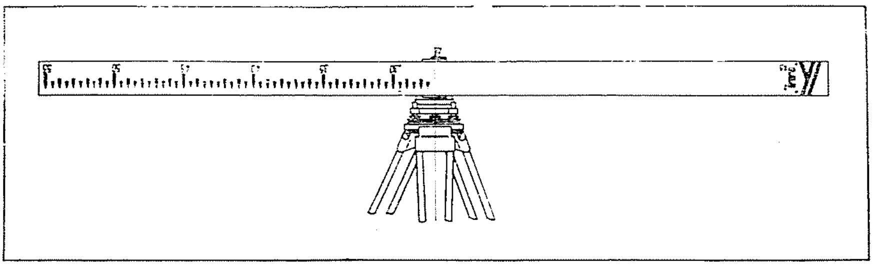


Fig. 3

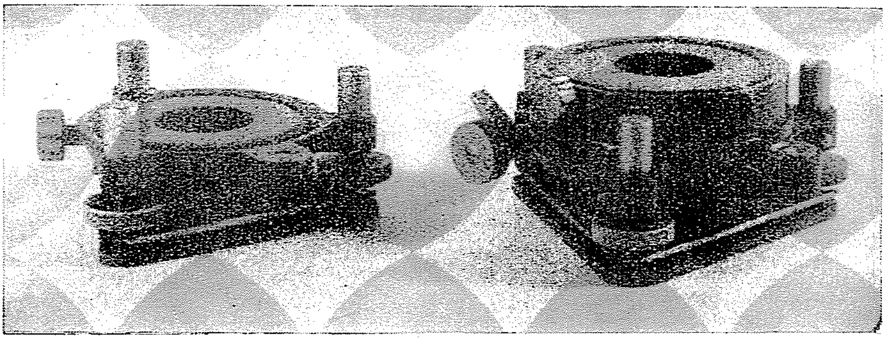


Fig. 4

fall out. Revolving the optical micrometer cause the two images of the same circle move in the same direction. In this way, a coincidence of a double line and an index can be arranged. The reading ability of optical micrometer is 10 seconds, but even single seconds can be reliably estimated.

The horizontal and the vertical circles are illuminated by a large mirror simultaneously, which can be adjusted to any direction.

When surveying at night, circles are illuminated by a flashlight bulb. Then the source of current is a great battery — applicable to tripod leg.

The axis system of the first few specimens of this instrument has been subsided to thorough examination in regard for tilting and resistance to wear. The measurements were accomplished in the same way as the theodolite Te—B1 had been examined, using two levels having a sensitivity of 1.2″ pro graduations each. The results, observed at every 45 degrees rotating the axis in the same direction, can be seen in the diagram of Fig. 6. The motion of bubbles in graduations per 2 mm, is plotted against the angle of rotation in degrees.

Table I contains the mean errors determined. As a result, the average value of mean

Table I

0°	±0.3905″
45°	±0.8828″
90°	±0.8259″
135°	±1.3254″
180°	±1.1639″
225°	±0.5746″
270°	±0.9971″
315°	±1.320″

errors does not exceed ±0.934″, at a temperature of +20° C. The absolute value of tilting was 3.96″ ; it occured at 315 degrees.

Examining these axis systems, no alteration could be found between temperature limits of —10° C and +40° C. These results clearly demonstrate that the axis is not susceptible to changes in temperature.

So much more sensitive is the axis to the accuracy and surface finish of ball tracks and to differences in diameter of balls.

The ball tracks have to be plain within the close limit of 0.2 μ, which can be controlled for Newton rings. The balls are selected with a special method to an extent of uniformity of 0.2 μ in the diameter.

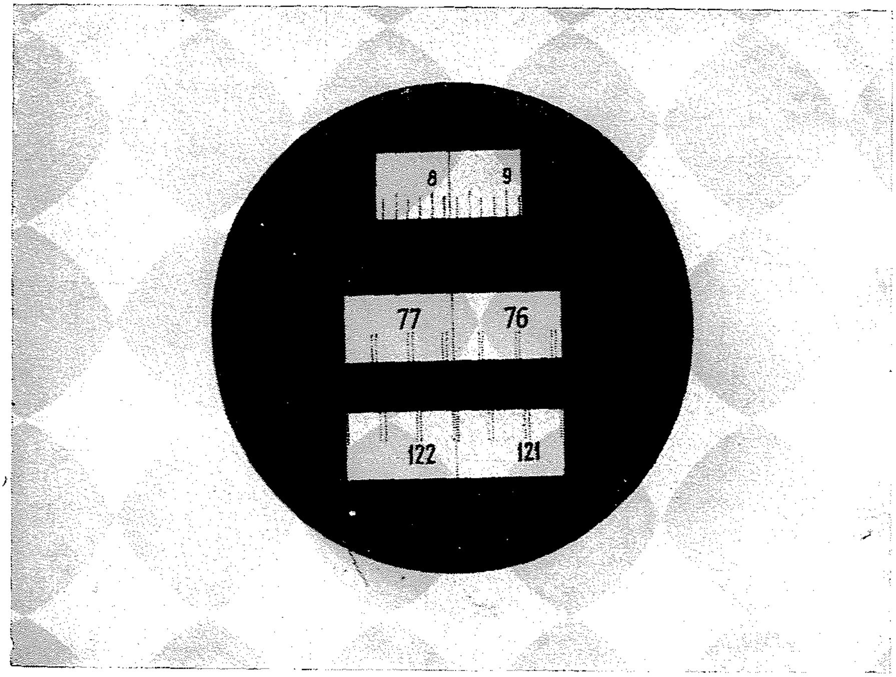


Fig. 5

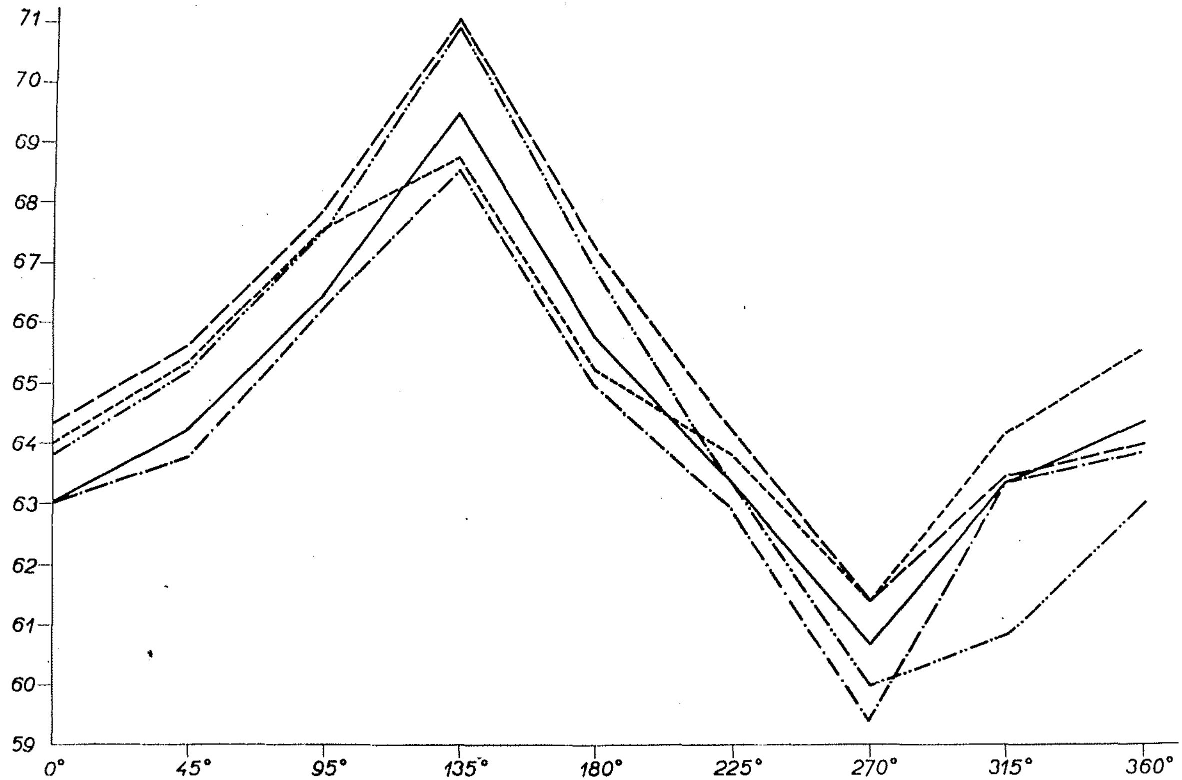


Fig. 6

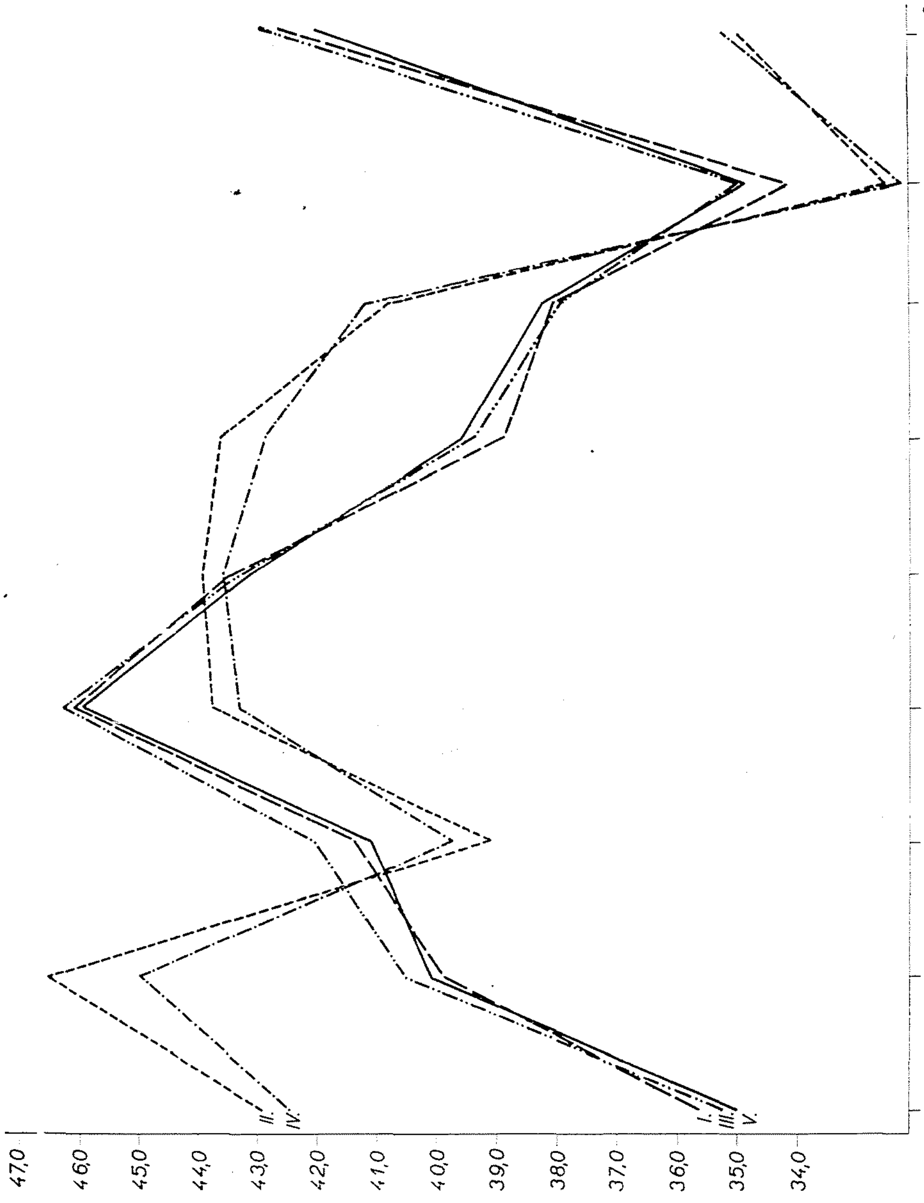

47,0
46,0
45,0
44,0
43,0
42,0
41,0
40,0
39,0
38,0
37,0
36,0
35,0
34,0
0°
45°
90°
135°
180°
225°
270°
315°
360°
I.
II.
III.
IV.
V.

Fig. 7

Fig. 7. shows the diagram of an axis system in which the aberration of the ball tracks from ideal plane was within 0.2 μ, but the difference between ball diameters was as much as ± 0.5 μ. The error from the balls can be clearly seen as causing periodic tilting repeated in every second rotation.

Table II

0°	$\pm$4.2154″
45°	$\pm$2.8530″
90°	$\pm$1.2287″
135°	$\pm$1.7121″
180°	$\pm$0.1601″
225°	$\pm$2.2578″
270°	$\pm$1.8736″
315°	$\pm$1.4220″

Table II contains the calculated values. The average value of mean error, gained from the Table is $\pm$2.607 seconds, the maximal value of tilting is 9.79″ at 0 degrees.

There is a tripod — telescopic or non-telescopic — a metal case and a wooden case for transportation belonging to the instrument.

The axis of the instrument is arrested automatically when put in the metal case.