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30 years development of drum bar threshing systems

Presented on the basis of East German combines

This paper looks at examples of important stages in the development, evaluated in the context of work elsewhere, of drum bar threshing systems followed by an outlook on possible future agricultural engineering development trends.

Straw walker combines have been developed and built in Saxony for almost 50 years now. Although direct comparison with western machinery was difficult in the then-DDR, agricultural engineering developments reflected the standards of that time as can be seen by a historical review.

Parallel to tangential system combines, different axial combines were being worked upon. Many results and much experience amassed during such work flowed into the developments of the straw walker machines.

From 1972 the Special Department for Agricultural Machinery, TU Dresden was involved through planned research in all aspects of development but especially in the construction groups threshing systems, grain cleaning and straw walkers.

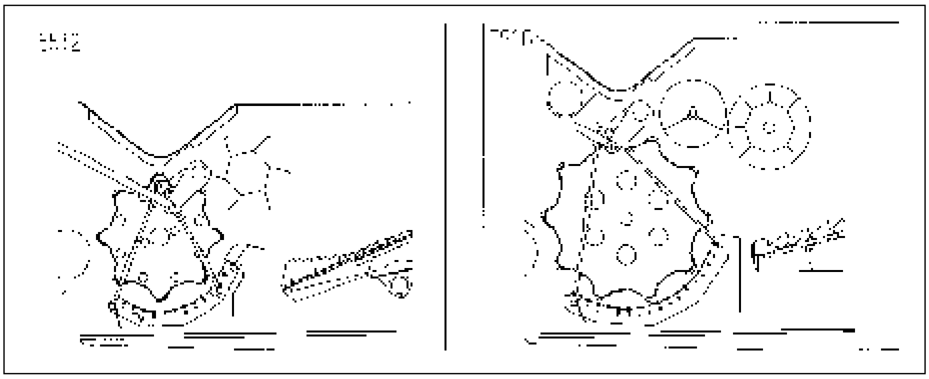

Fig. 1: Threshing system of the combines E 512 and E 516

This cooperation with industry was at that time developed with very much commitment by Professor Regge. Under his management in Dresden there developed a very dedicated working group which linked its tasks closely with the demands of industry.

In 1981 Dr. Bernhardt took over the management of this group and, as present incumbent of the Chair of Agricultural Machinery, he continues to be deeply involved in the development of threshing technology.

The most important development stages

The first complete own-development, the E 512 combine, went into serial production in 1968.

This machine had a classical drum bar threshing system with tangential through-flow of harvested material including drum, concave, follower drum and straw walkers (*fig. 1*).

The drum/concave working duo was at that time already well developed because drum diameter, drum bar form and number have scarcely altered in the ensuing years.

The concave, too, has remained much the same in basic design. The degree of wrap as well as distance from drum bars to one another lay within today's accepted range.

Modifications on drum bar spacing, concave wire diameter and spacing are available nowadays above all for the matching to various crops and harvesting conditions.

These relationships were already indicated during the first experimental investigations in Dresden where these parameters, and others, were varied and compared in their effects.

The demand for further increases in work efficacy could still be most easily met in the beginning of the 70s through building larger machines.

Thus the threshing channel was widened to a size still common today. There was still free room for lengthening of concave, walkers and sieves. These actions enabled a substantial increase in effective working area.

With the E516 from 1978 a machine was produced in series that already exploited the maximum permitted measurements for road travel.

Consistent filling of the sieve, even during slope work, as well as application of more powerful fans with more even air distribution in a larger separation area – these were the new challenges in those days.

Because of its large drum diameter and relatively large angle of concave wrap (*table 1*) the E516 combine had an unusually large concave area.

Through the special siting of the follower drum straw was deposited right at the beginning of the walkers so that total walker area could be exploited for separation. For support of this system a second follower drum with a smoother mantel was required (fig. 1).

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Keywords

Combine harvester, threshing system

The large drum treated the straw gently and its associated high moment of inertia meant it was also smooth-running.

Even with these measures productivity of the combines was almost doubled over a period of ten years.

In the following years increased cereal yields meant an increasingly urgent demand in farming for higher performance combines with large grain tanks.

With the above concept, however, there remained very little free space for increasing tank size because the threshing system with its 800 mm drum took up a lot of room.

For this reason research and development work was started in the direction of smaller threshing drums. The work was targeted at using the follower drum not only for transporting the straw but also for grain separation. This was achieved through new designs for the working elements and readjusted drum position with appropriate positioning of the concave separation area.

Additionally a separating drum was introduced, thus further increasing the proportion of centrifugal separation (*fig. 2*).

Thus with the development of E 527 came a compact, effective, multi-drum threshing system that allowed enough room for a large volume grain tank at, however, the cost of more intensive straw processing.

This machine went into serial production in 1993. Parallel to this work there were a variety of efforts to also increase the separation efficacy using the effects of gravity. So, along with the testing if different straw walker aids, there were also trials looking at the substitution of the walkers with rotating tine drums in differing configurations.

However, all this work had little success, it becoming apparent that, above a certain harvested material mattress thickness loosening the straw layers enough so that the grain could fall out easily and freely was no longer possible.

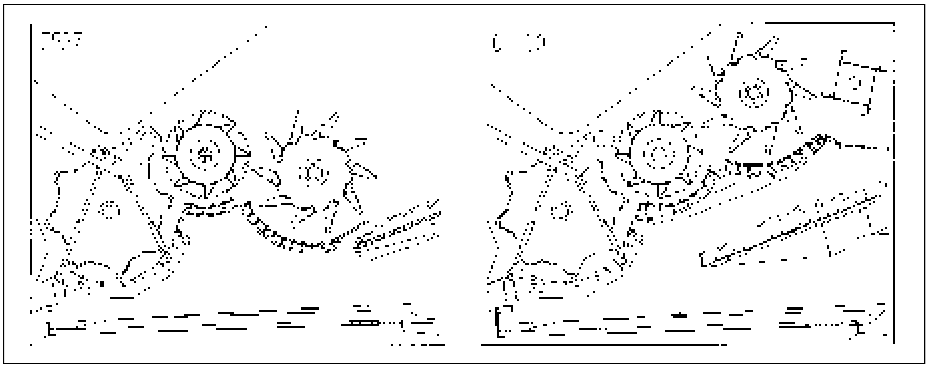

Fig. 2 Threshing systems of the combines E 527 and CF 80

And straw that was not completely desiccated at time of harvest made the separation of the grain from thick mattresses even more difficult.

In the last year the CF 80 took over from the E 527 as basis machine for a new combine model series. Through positioning the drum mid-point in a line and adding a fourth drum with separation fingers a further increase in separation area and optimum exploitation of constructional space was achieved (fig. 2). Where one varies channel width and juggles with the number of drums one can easily built on the basis of this threshing system a machine series with differing properties and varying productivities.

A very important point with multi-drum threshing systems is the relationship of the correct drum rpm with one another. A consistent material throughflow is a requirement for a high grain separation with low straw damage.

Outlook

Combine performance has increased over the previous years roughly in proportion to increases in cereal yield. This development will continue, because labour productivity should at least remain the same in terms of harvesting area.

In this context, engine power and grain tank volume must therefore continue to grow whilst ground pressure while downtime for transport and changing heads decreases.

Therefore the agricultural engineer will be faced with the task of fitting a system with increasing capacity into an area which might well become smaller meaning even more efficient use of space than that achieved so far. Even now, the channel width for walkers and cleaning elements has reached 2000 mm.

Should it be possible to fit the threshing and separating processing steps all in the feeder house, perhaps through the application of feeder house rotors, then a further reserve can be made available.

The mattress thickness on the walkers increases with larger throughput and this means that the proportion of active separation area will increase further.

Increasingly, various already known and new constructional elements will be combined with one another for new effects. Even now there are machines which cannot be definitely classified as tangential combines, axial combines, straw walker or rotary machines.

Development work will concentrate very strongly on increasing total technical efficiency and to this belongs the construction of working organs specially developed to meet the needs of different crops and harvesting conditions, also the development of electronic operating systems for adjustment and fully exploiting the machine as well as automatic control system for individual processing stages.

Table 1: Technical parameters of structural components

			E 512	E 516	E 527	CF 80
Threshing channel	breadth	mm	1278	1625	1632	1632
Drum	diameter	mm	600	800	600	600
	rpm range	min^{-1}	603 - 1300	280 -950	410 - 1240	210 -1250
Concave	wrap angle	grd	115	120	115	115
	area	m^2	0,81	1,43	1,02	1,02
Separation pan	area	m^2			1,23	1,79
Straw walkers	area	m^2	5,2	7,68	6,65	7,4
Grain tank	volume	m^3	2,3	4,5	8,3	9
Engine	power	kW	77	168	197	224
Production from	year		1968	1978	1993	2000