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RESEARCHES REGARDING THE MECHANO-PNEUMATIC DISTRIBUTION ON THE STRAW CEREALS SOWING MACHINES

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Abstract: This paper presents some theoretical considerations regarding the calculus, design and running of the mechano-pneumatic distribution devices which equip the straw cereals sowing machines. The distribution devices make the seeds measuring and their bleeding to the driven pipes for shovels. This measuring and bleeding process, named the seeds distribution process, affects over the main qualitative index of the sowing machine: flow rate stability, sowing norm, distribution uniformity on the working width, distribution uniformity on row. In paper there are accentuated the advantages of using these distribution devices types in contrast with the classical distribution devices.
Keywords: distribution device, measuring, seeds, technical equipment

INTRODUCTION

Lately, the sowing machines development especially concentrates on the improvement of the seeds distribution uniformity, tendency which much accentuated at present. As a result appeared several distribution device types, which satisfy more and more the sowing agro-technical requests, also the operating and design ones imposed to these machines.

The straw cereals seeds distribution devices are very important for ensure sowing quality and for realize light constructions of a low complexity, also determine the aggregate working speed. In other words the distribution devices determine: the seeds distribution uniformity, the seeds quantity per hectare, the seeds density, the seeds harm, the working speed, the sowing machine weight, adjustment possibilities of the seeds norm per hectare, the shape and sizes of the seeds tank and other characteristics of the sowing technical equipment.

Because of these elements can affirm that the seeds distribution devices are the main working parts of a sowing machine and by the way they works depend the sowing quality and sowing machine type.

CLASICAL DISTRIBUTION DEVICES

Distribution devices with fluted roller

The classical construction of the fluted roller distribution device is represented by a box fixed on the seeds tank bottom, where is the fluted roller. At some sowing machines the distribution device box is fixed laterally bottom, device feed is done by holes at the bottom of the seeds tank wall.

In figure 1 there are presented schematically two design solutions of distribution devices with fluted roller with the box in the lateral side (fig. 1, a) or in the bottom of the seeds tank. The adjustment of the seeds active layer is obtained with the lappets 1, their driving being in the same time for all machine distribution devices. For make the machine test there is provided the seeds collecting cradle 2.

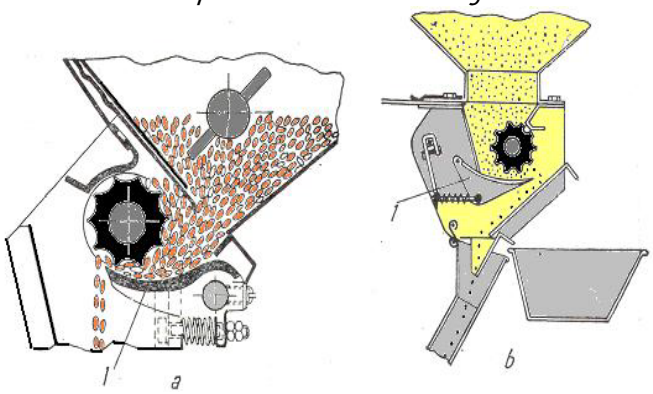


Figure 1 - Distribution devices with fluted roller

Distribution devices with spurs roller

The working and design principle of this distribution device is similar with the one of the distribution device with fluted roller.

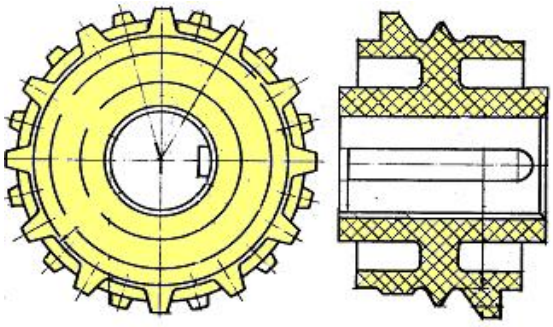


Figure 2 - Spur roller

The main working part is a roller (fig. 2) on whose surface there are disposed two rows of 12 spurs, between the spurs rows being provided a continuous rib, whose role is to direct the seeds to the spurs.

The spurs on the two rows are in zig zag shape, the spurs on a row being disposed in front of the gaps between the spurs from the second row, such a spurs disposal ensuring a better uniformity of the seeds flow, diminuting its pulsations.

The spurs rollers, which equip a sowing machine, are fixed on the same axle, each roller being closed in a box fixed on the lateral wall of the seeds tank, at its bottom (fig. 3).

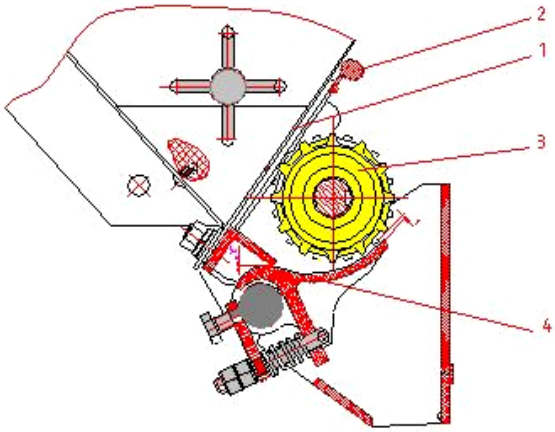


***Figure 3** - Spurs roller distribution device schedule*

The section of the hole from the seeds tank wall 1, through is ensured seeds feed of the distribution device, can be adjusted by the lappet 2 position modification. The mobile lappet 4 position towards the spurs roller 3 can be adjusted in terms of the seeds dimensions of the crop (the distance between spurs and lappet must be bigger than the seeds maximum size).

By spurs roller 3 rotation, seeds from tank come in the spurs action area where are driven by them and evacuated from the device. Through the spurs way of arrangement, each spur realizes seeds evacuation, ensuring a regular seeds flow.

The two distribution devices presented above are in the classical distribution devices which equip the straw cereals sowing machines, nowadays more and more diminuated. Lately, both on global plane and in our country there are used on a large scale technical equipments for straw cereals setting up with distribution devices with centralized measuring and pneumatic distribution, in other words mechano-pneumatic distribution devices. In contrast with the classical distribution devices, this device type has an advantages range. First, it allows the design simplifies and weight diminution of the sowing technical equipment for seeds tank capacity and efficiency increase. Because of the design characteristics of this device, that means a lots of possibilities to arrange it on the sowing machine, they may have more large working width than the universal sowing machines, in this way being reduced the passes on the field.

THEORETICAL STUDIES REGARDING THE MECHANO-PNEUMATIC DISTRIBUTION TYPE

At the mechanical measuring and pneumatic distribution devices the seeds measuring for all shovels are mechanical, with a fluted roller distributor and their repartition and transport for the shovels is done pneumatically. In figure 4 there is presented the working principle of the device with mechanical measuring and pneumatic distribution: from the tank 1, the seeds measured from the fluted roller 2 are evacuated in the conduct 3, where the air flow made from the fan 4 takes them. From the horizontal conduct 5 for the distribution main head 6, where on make the air and seeds mixture primary distribution for the secondary distribution heads 7, 6-8 in number, which every conduct the seeds mixture for 6-8 shovels. The secondary distribution heads are installed on homogenization vertical pipes (mounted on the machinery frame), like the vertical pipe 5, but with a smaller diameter. The place where the seeds are taken by the air flow must have a Venturi (shape) construction towards obviate of some additional pressures witch upset the seeds back for the distribution device. The vertical conduct walls, on the last region, before the distribution main head, are gofers for the insurance of the air-seeds mixture homogenization.

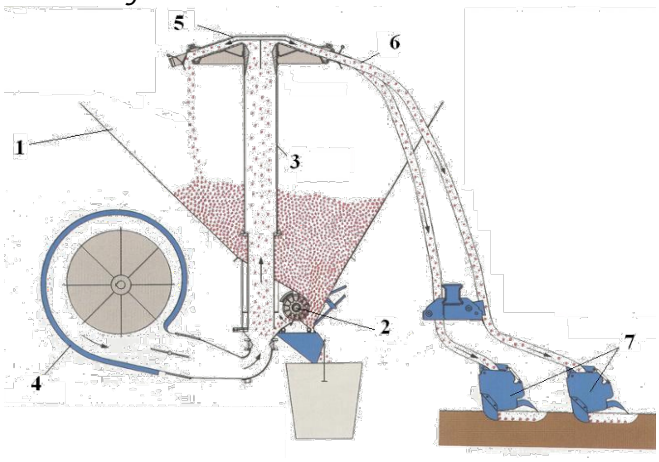


***Figure 4** - Device with mechanical measuring and pneumatic distribution*

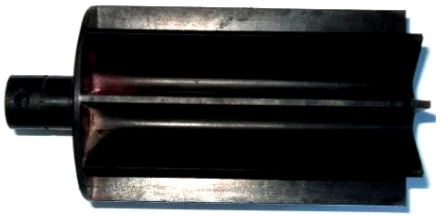


***Figure 5** - Mechanical dosimeter as fluted roller type*

The main requests imposed to the mechanic fluted roller (fig. 5) which equips the straw cereals sowing machines:

- *can be used to sowing a large crops number; in this aim the fluted roller must be provided with the possibility of the flows rate adjustment corresponding to the sowing norms imposed for each crop, to the distance between rows and to the seeds working depth, in accordance with the setting up technologies for each crop;*
- *to ensure an uniform flow rate, respectively the sowing norms, in the limits of the working speeds, corresponding to the sowing machine exploitation conditions;*
- *to ensure an uniform seeds distribution both on the machine working width and on row; to this effect they must measuring equal seeds quantities;*

» *the ratio between the seeds dosimeter rotation speed and the sowing machine advance speed must be constantly, at the same adjustment;*
» *in the distribution process seeds mustn't be broken.*

The main requests imposed to the pneumatic distribution (fig. 6) are:

» *the place where seeds are taken by the air flow must have a Venturi construction (shape), for avoid some overpressures which throw back seeds to the distribution device;*
» *the vertical pipe walls, on the last segment, before the main distribution head, must be goffered for ensure the air-seeds mixture uniformity;*
» *the seeds flow sent to the shovels must be uniform, respectively on the length unit of each row must be distributed the same seeds quantities;*
» *the air flow speed in the transport and distribution process must be bigger than the critical seeds floating; the cereals seeds critical floating speed being generally between 9...14 m/s, result that in the main pipe the air speed must be 20...25 m/s.*

a)
b)

Figure 6 *- Pneumatic distribution*
a) fan; b) vertical pipe and distribution head

In terms of their destination, the sowing machines equipped with such distribution devices work on 24...90 rows, the distribution device ensuring the norm adjustment between 2...360 kg/ha.

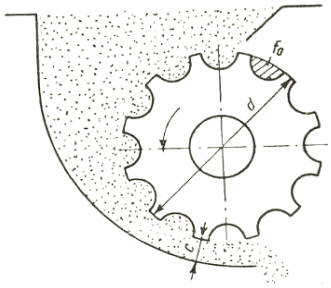


Figure 7 *- Working schedule of the fluted roller distribution devices*

Calculus elements of the seeds dosimeter as fluted roller type

The distribution device with fluted roller realizes both the seeds constrained distribution (seeds in the flutes) and the seeds free distribution (seeds in the active layer). The thickness c (fig. 7) of the active layer depends on the lappet position which limits the bottom size.

Seeds volume evacuated by the fluted roller distribution device

The seeds flow rate is:

$$q = \frac{V_d \cdot n_d \cdot \rho}{60} \ [\frac{kg}{s}] \qquad (1)$$

where: V_d is the seeds volume distributed at one fluted roller rotation [m^3/rot]; n_d – distribution device rotation speed [rot/min]; ρ – the seeds volume mass [kg/m^3].

On determine the seeds volume distributed at one fluted roller rotation with the relation:

$$V_d = V_0 + V_a \quad [m^3/rot] \qquad (2)$$

where: V_0 is the seeds volume evacuee from the flutes (forced distribution) [m^3]; V_a – the seeds volume from the active layer [m^3];

The seeds volume evacuated at one fluted rollers rotation is:

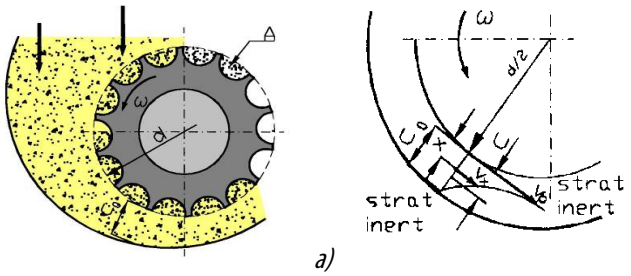
$$V_0 = A \cdot L \cdot z \cdot \psi \ [m^3/rot] \qquad (3)$$

where: A is the one flute section area [m^2]; L – the fluted drum active lenght [m]; z – number of flutes; $\psi = 0,93....0,98$ for small seeds, $\psi = 0,60....0,85$ for big seeds.

Calculus of the active layer thickness of the fluted roller distribution device

The active layer (fig. 8, a and b) has a roller shape, of c_0 depth, concentrical with the fluted roller; this layer seeds are driven in rotating motion because of the friction forces between the fluted roller and the seeds and seeds themselves.

The active roller seeds pass with different speeds, the speed value decrease in the same time with the distance increment till the fluted roller (fig. 8, b).



a) b)

Figure 8 *- Calculus of the active layer thickness of the fluted roller distribution device*

The speed value in an x active layer section is gived from a rule as:

$$v_x = v_p(1 - \frac{x}{c_0})^m \qquad (4)$$

where: v_x is the seeds speed wich are at x distance from the fluted roller; v_p – the fluted drum peripheral speed; m – exponent wich value is experimental determineed for several crop seeds; m = 2,6 for wheat, oat, barley seeds.

Come up the seeds debits which flow through the active layer of c_0 depth and through the accepted depth c_0 layer on obtain the identity:

$$c \cdot v_p \cdot L = L \cdot v_p c_0 \int_0^{c_0} (1 - \frac{x}{c_0})^m \cdot dx \qquad (5)$$

and by integration on obtain:

$$c = \frac{c_0}{1+m} \qquad (6)$$

The necessary Q_a air volume debit for the q seeds debit pneumatic transport is:

$$Q_a = \frac{q}{\mu \rho_a} \ [\frac{m^3}{s}] \qquad (7)$$

where: μ – the air-seeds mixture gravimetric concentration coefficient; μ = 0.3….5; ρ_a – the air volume mass [kg/m³].

The v_a air current speed in the distribution and transport process must be bigger than the floating critical seeds speed:

$$v_a = (1,3.....2,5) \cdot v_{cr} \qquad (8)$$

where: v_{cr} is the floating critical seeds speed.

The D_c diameter of the main seeds transport and distribution pipe.

On settle the D_c diameter in terms of Q_a şi v_a from the equality:

$$\frac{\pi \cdot D_0^2}{4} \cdot v_a = \frac{q}{\mu \cdot \rho_a} \qquad (9)$$

and results:

$$D_c = \sqrt{\frac{4 \cdot q}{\pi \cdot v_a . \mu \cdot \rho_a}} \qquad (10)$$

CONCLUSIONS

The seeds measuring and evacuation process determine the qualitative working index of the seeding machines as: the debit stability in the working process, the distribution uniformity on the working width of the seeding machine and the distribution uniformity on the plants row. To this effect the measuring and evacuation devices calculus and dimensioning is very important.

The utilization of these measuring devices present the advantage of a good measure precision at high working speeds (on insurance debits from 0 to 400 kg/ha at working speeds from 7 to 12 km/h) and allows an easy and safety adjustment of the seeds quantity in accordance with the agro-technical norms, for each crop.

At present on observe a tendency for a continuous improvement of the centralized distribution devices, especially because the sowing machines equipped with such distribution devices, in contrast with the ones equipped with individual distribution, have a compact design, large working widths, high maneuverability and a large utilization area.

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