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Threshing Machines (from Zemlediel'cheskii zhurnal [Agricultural Journal], no. 29 , 1830, pp. 264-86)

Remarks for their inventors and for those who improve upon them, as well as for landowners who wish to introduce these machines on their [farms]. -- D. Ch. Flota [*sic*; cf. version on text p. 286]

Whoever should want to invent something new, or to renovate something antiquated, should be immediately aware that in this respect we are resourceful times. What changes and novelties have been made! And how useful and how advantageous (or not) have these inventions and excellent things been!

Without preliminary information, even with the very best knowledge of the basics of mechanics, we would never progress ahead. What was invented and discarded long ago, if we think about it accidentally, we will consider as a new invention, and in this way, we will keep turning in a single circle, without further success. This observation can prove useful in particular for those who not only make use of past inventions, but also for those who [p.265] present them for general knowledge and try to receive credit for their invention. An inventor of such machines, losing much time and money in experimentation and in changing what long ago was already investigated, altered, and discarded, often thereby upsets his own good fortune and becomes the cause of a disastrous situation for his own family.

Of all the agricultural machines known in our country, most are used by landowners and by mechanics for grinding grain or for threshing. This is a sign that there is still hardly a single thresher that has fully responded to landowners' expectations. Up to now, we know perhaps of at least 60 various kinds of threshers. But of these, many are similar to others in their basic structure, and are distinctive only in their separate parts and in the smallest modifications. But these differences have been publicized by ignorant people as completely new inventions.

As regards the main structure of threshers, all of those invented up to the present can be divided into the following types:

[p.266] 1) *Threshing sleds*, whose bottoms consist of deep, cross-cut strips, which pass across the sheaves, and in this way beat the grain out of them. These sleds are of the most ancient invention, and it's well understood that they could be considered as satisfactory threshing implements only when mechanical arts were in their infancy. They could also appear useful in a hot or consistently clear climate, where the kernels break loose on their own from the ears.

2) *Threshing carts*, invented by Italians and long utilized in southern, dry locales. In Italy, as we know, grain is threshed mostly in the hills and in open fields. The kernels there remain so weakly attached to the ear that the very slightest blow sets them loose. Thus, when horses or oxen pass through the scattered grain a few times, it easily gets threshed. These carts, with four or more wheels, with broad, notched spokes on a single axle, are quite successful. They thresh well, but avoid straw too much, which of course is unimportant in Italy, [267] where they don't know how to use straw at all to cover

roof tops.

The invention of threshing carts also belongs to the distant past. Despite this, four years ago a certain Mondellino in the Kingdom of Lombardy announced that a threshing cart he devised was a completely new invention, and for this he received a patent from the Austrian and Sardinian governments.

In Italy such a cart is quite useful, and it can be successfully utilized even in Lithuania, where all grains are dried out in kilns prior to threshing. But in our usual [Russian] economic circumstances it is completely worthless. I mentioned that this machine has been greatly praised and was represented in a drawing in a German journal from 1825, *Oekonomische Neuigkeiten*, and that more than one of them has led to seemingly useless expenditures.

3) *Threshers with chains*. This type of thresher is the most numerous. Almost every inventor of a thresher tries to take off on threshing with chains. But all these gentlemen are mistaken in their calculation. These threshers, along with others, were invented, for the most past, either [268] by agriculturalists or by mechanics unfamiliar with agricultural needs or with the art of threshing. The first [such] thresher that we know of was invented over 160 years ago in Courland [Latvia]. A sufficiently circular threshing floor rotated horizontally below the chains, set in motion by a team of six horses [alternative translations: pinion or gear; in context, this is less likely]. From one side, threshing took place upon it, while from the other side a man took away the detached sheaves and added new ones. The middle of this threshing floor was built on a slope and with holes into which the beaten kernels were poured. Underneath was a drawer (*kosk*) and a seed-lip [basket]. In this way the clean threshed grain could be instantly obtained.

So it's evident that the first of this kind of thresher has been quite an improvement and has been superior to all the latest ones. Moreover, among recent inventors of threshers, not one, it seems, had information about this [first machine from Courland]. We know nothing about its operation. A similar thresher was made in Marymount [a suburb of Warsaw] in 1818 by a mechanic named Krueger. This one, however, was not operational, due to its poor workmanship and weak action.

In 1700 in Hanover another thresher with chains was invented, but its threshing floor [269] (*klepisko*) lay upon shafts, and workers moved it manually back and forth, so consequently this thresher was much worse than the first one. Among such [machines] belongs the one made as a model in 1829 by the [Russian] State Commission of Internal Affairs and presented as a new invention.

Pastor Pesler in the Duchy of Brunswick invented a thresher with chains, whose action was reinforced by repellent springs. Its threshing floor was completely like the first thresher described here; for about 50 years it had a great reputation.

The most recent inventors have fastened the chains onto the shaft (cylinder) itself, which turned either by means of a gateway or by a toothed pinion. The chains were attached to the cylinder either by straps or by smaller chains. As the cylinder turned, the chains struck against the boards of the threshing floor, which lay immobile and facing them. But noteworthy here was that the chains attached this way got tangled up together during the operation, and the cylinder rotated all the more forcefully, so that the [chains] were given more centrifugal [rotary] motion and threshed less effectively.

Also through the [270] rotation of the cylinder and the chains catching hold of it under the threshing floor, the straw was strewn about too much and was dragged off, in part, under the flooring. Despite this, five or six of these threshers of this construction were invented, with minor changes. One of these, around 1770, was found on the estate of Count Podewiltz in Gusov, not far from Meglino [a lake in NW Russia east of Novgorod].

As a consequence, all these machines were marginally successful in operation. The chains broke all the time, and for the most part they only beat the grain with their tips, etc. So, as a consequence, these threshers with chains were abandoned.

Kusayevsky's thresher, which was never put to use, also had chains. Despite this, three years ago, Agronomy Professor Stecker at Lviv [then Lemberg in the Austrian Empire] declared he had invented a new thresher with chains. I recently received from him a description and sketch of it. He wanted to eliminate from this thresher all the inadequacies of the earlier chains – chains getting tangled up, so that the grain was not beaten for the entire length, and straw being drawn off – so that it would operate more successfully and forcefully [271]. Its structure was as follows:

A post, standing 4 ½ feet high above the ground, is driven in the center of whatever location is integral to the threshing process; this should be at least 40 feet long and wide. Around the post three circles are outlined; the first, about 2 ells [54". (The Dutch length ell, 27", was most likely in used in Russia, imported by Peter I)] from the post, is drawn on clay, which serves as the threshing floor. Another circle, about 5 ells [11'] away from the first one (and about seven ells from the post) outlines the threshing floor itself, which begins about two ells from the post, encircles it, and extends about 5 or more ells across.

This threshing floor is solidly surfaced with joists. Around the floor, i.e. for about 7 ells [16'] from the post, is a wall made of little posts and boards as high as the post in the center. Behind this wall (between the second and third circles) is a place for the horses which turn the machine. For threshing Stecker uses drums *(bebna)* made of tough wooden strips, on which eight chains are fastened by iron nodes in various places. Across the middle of the drum a strong [272] iron axle extends, whose one end rests on the center post, where it can turn around a *coupling bolt*; the other end of the axle is on the wall, where by means of a small wheel it can easily be turned along with the *drum*.

Beyond the wall is a place where a horse, driving the axle, can proceed in a circle and rotate the drum, along with the chains, which in this way thresh the grain spread out on the threshing floor. On a floor such as this, *half-piles* [*half-kopnas*] of winter grain can be spread out all at once. Two *drums*, moving one after another over the course of 45 minutes, along with turning over the straw on the threshing floor and gathering and tying up it up, thresh the *half-piles*.

And so the very largest amount of winter grain, which this machine threshes daily will be six piles (*kopnas*). Besides two horses, two people are needed for this: one to drive the horses, and the other to stir up and turn over the straw on the threshing floor. Special workers are needed for winnowing.

Such a machine is used around Lviv [West Ukraine; then in the Austrian Empire]. It costs over 600 zloty [Polish currency] to build. [273] However, as evident, these threshers are much more efficient than the earlier chain threshers. Their success, however, in comparison with Scottish threshers (to be discussed below) , is rather minimal, and thus, despite Mr. Stecker's assertions regarding the usefulness of this machine, it will never be acceptable for use.

Inventors of threshers should also recall that threshing with a chain, manually activated, is completely different from threshing with chains acting on their own. In the latter instance the chain strikes only by its own weight, whereas in the former, man-power is added to it. The chain automatically makes contact even where it is unnecessary and where contact is useless, or even harmful. In human hands a chain always hits the appropriate place; not one blow is useless, and in particular they strike where each entire kernel can easily separate, with the requisite pulling and forceful shaking of the ears.

One blow, manually, is more effective than three or four by machine. [274] For these reasons we deservedly turn our attention to a proposal to set up a two-strike chain system found in one of the well-known German works, *Grundsaetze des landwirthschaftlichen Maschinenwesens* [Foundations of Agricultural Machinery], translated from English. The author has made experiments on chains with two beaters, manually guided, and with identical application of force, he threshed almost twice as much as a single chain could do.

4). The special kind of *Threshers with pestles*. Convinced of the minor success of the first threshers with chains, inventors around 1770 came up with machines with 'pestles.' These pestles were raised by means of teeth set on a mobile cylinder. The pounding of these pestles, of which there were usually more than ten in one or two rows, was actually more successful than were the effects of chains. But this was inconvenient only in that lots of kernels were scattered, which afterwards made them worthless for seed or for making malt, or even for trading, since they did not look good.

In England, when these threshers came into fashion, people paid for grain threshed by pestles [275] 10 to 20% less than they did for grain threshed by hand. Although three or four of these threshers were invented with certain changes, this was the main reason they have now been completely abandoned, and you hardly ever see these models.

5) *Threshers with ribbed cylinders* were invented in 1754 in Stockholm. These cylinders, or rollers, quite thick and heavy, rotate close to the ground on a mobile shaft. With this roller turning on the threshing floor and around the post, activated by a horse, the grain scattered on the floor is thereby threshed. This method can be called trampling rather than threshing the kernels. This trampling has the same drawbacks as does the beating method with pestles, and thus these

threshers have gone out of use.

Around 1800, however, in our own times, a certain Missel {Muessel?] in Saxony renovated this thresher with rollers *(walcami)*. His thresher was like the machine of Mr. Christiani, invented for braking flax. A few small shafts lie around a large one, and are attached to a rope. The grain is spread out underneath [276] them. With the rotation of the large shaft, the smaller ones turn as well. The grain passes between the shafts, and the kernels are pressed out this way. This thresher soon turned out to be worthless in application. Surprisingly, however, twenty years later it was proposed with great fanfare as a completely new invention for braking flax: yet even for this it was soon recognized as unfit.

6) The type of *thresher* which belongs to the newest and most effective ones, and which, up to now, has been welcomed with great acclaim among us [in Russia] and in other countries, is the so-called *Scottish thresher*, invented by the Englishman [sic; actually Scotsman, Andrew] Meikle [in 1784]. Here the grain is placed between two furrowed shafts, which draw in the ears and the straw. Underneath them is a drum with pinions which turn with astonishing speed and thereby thresh the grain. Its structure is described in detail in many works on agricultural economics. This thresher has also been subject to many improvements and changes. These, however, do not relate to its main mechanical structure, but only [277] to separate parts.

This is also called a Swedish thresher, because changes in it were first made in Stockholm. In France, Mr. Ubriot made yet a few more minor changes; thus there they call it *Ubriot's thresher.* The biggest drawback of this machine is that it is too expensive. However, it is not very large. With three or four horses it threshes daily 12 kopnas [7200 kg] of winter wheat (each kopna equals 12 zentners [one German Zentner = 50 kilos]), and up to 14 kopnas of spring wheat [8400 kg].

It costs 1600 zlotys at Mr. Evans' factory, and with fittings and a shed for shelter, about 2000 zloty. Inasmuch as the Scottish thresher has many wheels, cylinders, etc. made of cast-iron, from this it seems that its cost should be rather significant. So we began to make the cast-iron parts simply out of wood; but up to now the cost of wooden threshers is not much cheaper than of those built with iron accessories. But threshing with them needs much greater power, and wooden parts are subject to frequent repairs. And yet one can even say that these Scottish threshers [278] all too often pass over or break the straw. But this is worth our special attention, for we know that broken straw is still better as fodder or bedding, and makes it easier to prepare chopped straw. As regards thatched roofing, even the most worthless part of straw is useful for this, for this can even be threshed by hand.

This machine, however, fully serves its purpose. Despite this, farm workers unacquainted with mechanics, and [shop] mechanics unfamiliar with agriculture, rack their brains when they need ways to thresh both quantity and quality with this machine, and still get the right kind of straw. Some of them attribute to it rather miraculous methods: as, for example, a few years ago in the newspaper *Der Land- und Hauswirth* [Agricultural and Home Economics], someone advised using for grain-harvesting an implement similar to a large pair of scissors, under which a bag is attached; this device was just to cut ears of grain. The ears were to fall into the bag that lay beneath the scissors. The ears were to be threshed [279] in the Scottish machine, and the straw without the ears was then to be used, if necessary, as sheaf material.

7) *The Threshers invented by Prince Gagarin and Moland* (See Zemledielcheskskii zhurnal, no. xxviii, p. 180), as mentioned and described in the 9th issue of *Polska Izida*, in 1824. This type is based on the fact that pinions rotating horizontally on a vertical and mobile spindle are set in motion by means of a tooth cog-wheel and by animal power. Moreover, these pinions move fast. At same distance above them are boxes similar to rolling scoops with small openings at the bottom. The sheaves with the ears facing downward are placed into these boxes. The pinions in their rapid rotation beat against the ears, and in this way the grain is threshed very quickly and cleanly. This is a new idea, and for this reason it has not yet been brought to perfection. And so we need to hope that mechanics and skillful landowners will turn their attention to this. The success of adjustments and a few alterations on this machine [280] would be much more fortunate and advantageous than on threshers with chains, pestles, wheels, threshing shafts, etc.

Having presented all the kinds of threshing methods known to date, along with their success –major or minor, and their merits and drawbacks in economic respects, I still need to show landowners the benefits that can accrue from utilizing the very best of these threshers to date – for example, the Scottish one. I will not discuss the ones less perfected, for one can only expect setbacks in putting them to use.

The majority of landowners have hoped for too many advantages from having threshers. This is already clearly evident from the fact that descriptions of them state that only two or three boys and a couple of horses are needed.
But this is wrong. On the estate of the Agronomy Institute a few years ago there was a Scottish thresher from Mr. Evans' factory which was among the very best. And for this reason I am in a position to give a detailed account of it, based on experience.

In the vicinity of Warsaw a worker on *barshchina* [serf contract-labor] can thresh in a day [281] a half-kopna of winter wheat (a kopna weighs 12 *zentners* [600 kilos], which yields 6 *chetveriks* [about 4.5 bushels] of grain), and three *krestsy* of spring wheat (one kopna of spring wheat weigns about 9 *zentners* [450 kilos], yielding 6 to 8 *chetveriks* of grain [4.5 to 6 bushels]. The worker himself tosses aside the threshed grain from the granary rack, unbinds the sheaves, ties up the threshed straw, carries off the sheaves, and winnows the grain.

Now let us take a look at how much power is needed for a smaller threshing machine, which processes 12 kopna [144 zentner; 7200 kilos] of winter wheat per day:

1) A pair of strong horses, which can work for only 2 or 3 hours and then are replaced without fail by another pair. This is why a small threshing machine needs to have four horses who can work alternately. And in so far as keeping one horse with harness costs as least as much as one day's pay for a worker, so four horses take the place of four day-laborers, when it comes to expenses.

2) Personnel needed for this threshing machine:

- one person to drive the horses and to watch over the other pair; [282]
- one person to press the grain into the cylinders;
- one person to undo the sheaves and to hand them to the first person;
- one person to bring in the sheaves, if they're located some distance away;
- one boy to take out and toss away the straw emitted by the machine;
- one person to rake up the straw and tie it into bundles;
- one person to carry off the straw, threshed and bundled;
- two people to clean the grain that has been threshed.

So in order to thresh 12 kopnas of winter wheat, you would need per day nine men and four horses, and expenses to cover 13 workers. Thirteen workers can thresh 6 ½ kopnas [3900 kg] per day with simple chains, and so you are ahead by 5½ kopnas per day [i.e. 12 kopnas are produced per day by a small thresher]. Since in the Warsaw area in winter one pays 25 groschen [15 kopeks] per kopna, to hire someone to thresh an extra 5½ kopnas of winter wheat by thresher costs 9 zloty; and at 12 kopnas the thresher by itself earns 9 zloty.

From this gain we may exclude whatever it costs to maintain and repair [283] the machine: not less than the percentage of the invested capital, and still a percentage toward collecting funds for the purchase of a new thresher, once the previous one is fully disabled.

So the calculation runs as follows: if we assume that the thresher with all its accessories costs 2000 zloty [i.e. 1200 rubles; with a ruble then at roughly $.45, this would be $540]:

1) 5% as the percentage of capital invested	100 zl.
2) 10% for the amount to set up a new machine, when the previous one becomes worthless (a thresher like this can last an estimated 10 years)	200 zl.
3) for grease to lubricate in winter, at least	30 zl.
4) for annual repairs, at least 4% of the capital	80 zl.
From this, a yearly expenditure on a thresher	410 zl*.

(* a Polish zlot = 60 kopecks)

Inasmuch as the machine earns 9 zloty each day, we should then thresh at least 46 days each year for the thresher to pay for its upkeep. At this time it would thresh [p. 284] 552 kopnas [330,000 kilos] of winter wheat or a correspondingly greater amount of spring wheat [at 12 kopnas/day on average].

And it's evident from this that only those landowners will clearly gain from a thresher who thresh more than 46 days a year. Although it's possible to work with a thresher more than 120 days annually (assuming that besides sowing season, threshing cannot be done while other types of field work take priority). So in the most fortunate context, a land-owner may choose to thresh 74 times a year, averaging a return of 9 zloty each time, which would total a yearly income of 666 zloty [ca. $180 @ $.45/ruble].

The larger threshers, which are more expensive, which need more horses to set them in motion, and need more people too, are not as advantageous to many. A landowner who brings in less than 550 kopnas [330,000 kilos] per harvest would certainly sustain a loss from using a thresher.

The structure and application of threshers deserves attention, however, in the following circumstances:

1) Where harvests are quite large and where in winter there is not enough serf labor to thresh them.

2) Where hired workers are expensive or they are never available when needed. [285] Where a threshing worker in winter gets less per day than what 1/15th of a basket of rye costs, or where there might be an excess of people who would like to thresh harvests at 1/10 or 1/12 part of the seed grain, then it would no doubt be more advantageous to use them instead of threshing by machine. And likewise in countries where the agricultural class is quite small in size or even where threshers are not evident.

3) Threshers also render considerable service to landowners in August and September, when amidst lots of field work, it's necessary to keep pushing ahead with threshing grain for seed. At such times, even though landowners may also receive compensation for their expenditures, they gain in every way in both time and manpower, which is also quite important,

To conclude my remarks about threshers, I should add yet a few more observations regarding their motor force. I have recognized from experience that even the most minimal success in energizing machines comes from manpower. Horsepower produces even greater and more useful transformations. One horse has greater strength and can work longer than six men; [286] horses also have greater speed.

Thus, whenever it's possible to make use of horsepower, it will be 6 to 9 times more efficient than manpower. For this reason alone, all manual threshers, without exception, cannot be used very effectively. Waterpower or steam-power as a method would be even more successful than horsepower. Thus whenever the last two kinds of power can be applied effectively, then landowners would need not utilize any other kind of energy.

D. Ch. Flat

The following description of a Scottish threshing machine, as perfected by Mr. Dombasle, is appended to the preceding article.

[Between pp. 286 and 287 is inserted a sketch of threshing machine parts, labeled figure 2 (above) and figure 5 (below) Lines A and D-B run horizontally; line C-D runs vertically. Component machine parts are numbered intermittently from 5 to 58. Although figures 2 and 5 share several of the numbered components (7, 22,23, 29, & 47), a preponderance of the lower numbers are found in figure 2; and of the higher ones in figure 5. Figures 1, 3-4, and 7, alluded to in the following text, are absent. – translator's remarks]

[p. 287]

A Description of Mr. Dombasle's Threshing Machine and of Some Others, with a Sketch. [by Mr. Valcour]

Mr. Dombasle [Mathieu de Dombasle, founder of an agricultural school near Nancy, France, in 1822] has not had enough space to set up his threshing machine, the operation of which also sets in motion the cylinders which crush potatoes for distilling, and activates a pump that provides the entire amount of water it needs. Besides this, the shaft {4} (or the axle) moves a small mill built for producing malt.

From the center of action {1} to the place where he could set up his threshing machine, the distance is 30 feet. Lacking wood long enough for an entire shaft, he was forced to make two of them {4 & 7} and to build his machine with triple gearing (*Engrenage*). Wheels 1, 2, 3, 5 & 6 had served him at his sugar-beet factory. The space taken up by the thresher has a diameter of 18 feet, 6 inches, which is quite insufficient as a suitable path for the horses that turn the machine.

I proposed that we should [288] be aware in advance about these difficulties that bothered Mr. Dombasle regarding the abovementioned shaft complication, but which are really needless. In describing this machine I shall preserve the same numbers, which are also repeated in the other figures.

Figure 1. View of the overall structure in a lay-out sketch.

Figure 2. View of the thresher, also from above

Figure 3. View of figure 2, in profile on a cut along the line CD.

Figure 4. View of figure 2 on a cut along line AB.

Figure 5. Profile on a cut along line EF of figure 4.

Figure 6. Exterior view of Mr. Hoffman's machine.

Figure 7. The same machine along a line from the center. I did not make a lay-out or profile from the front, because they are quite similar to figures 2 and 5.

The worker placed on the ground {53, of fig. 4}is carrying a load of grain from the sheaves lying near him that more or less reflects the force with which the machine operates. The grain is spread out evenly on the board {54}, with the ears in front. And as soon as it is carried away, he pushes a new load toward the attracting+ or wired cylinders {14 and 15}. These drag the grain forward and subject it to the blows of the swingles, which, striking downward, pass it along the concave, ribbed surface {25} and [289] throw both the straw and the kernels onto the boards {29}, which form the blades of the rake {30}; the rake leads everything through a grating {34}; the kernels and the small-sized straw pass through this. The large-sized straw is dragged off by the teeth of the rake away from the grating and drops along a sloping plane {35}, where a man stands and ties them up with the same straps that the sheaves are tied with.

The kernels, the finer straw, and the chaff, passing through the grating {34}, slide along sloping planes 36 & 37. Falling into 39, they meet a strong blast of air produced by a "blower" {43}. They pass through an aperture {45} and rush along the sloping plane {40}. The good kernels, of their own weight, roll along this surface {40} and fall into a bag placed there {46}, whereas the lighter kernels scatter {in 41}, and the chaff and finer straw blow off {into 42}.

Now follows a description of the various parts of the machine.

A large or main wheel in the structure [2, fig. 1] has 94 teeth or cams; the pinions {3} have 24 spools; a wheel {5} set on the other end of the shaft {4} has 48 teeth; and the pinion there {6} has 21 spools. A cast-iron wheel {8, fig. 2} on a shaft {7} has 80 teeth; and the pinion {9} fitted on the axle of the threshing cylinder {290] has 10 teeth. [290]

Now, multiplying the number of teeth on the three wheels {2, 5, & 8} – 94 x 48 x 80, respectively – gives us 360,960. Similarly, multiplying the number of spools from the pinions {3, 6 & 9} – 24 x 21 x 10 – gives us over 5,000. Dividing the first product (360,960) by the second (5040) gives a quotient of 71 2/3, which multiplied by 3¼, the number of circles the horses make in one minute, we get 233, as the number of revolutions made by the threshing cylinder {9 & 10}in one minute.

All the English works prescribe 200 to 300 revolutions per minute for the threshing cylinder. The great speed of the thresher's movement constitutes the chief merit of this machine. The center of the thresher is three feet in diameter, so that the four swingles reach a velocity of 2194 feet per minute [71.66 x 300 = 2149; "2194" is presumably a text error]. The shaft {9} of the threshing cylinder on its other end has a pinion {18}, and an axle up against 11 cogs {fig. 3}, which catches onto a cast-iron wheel {19} that has 31 teeth. This also rotates a cast-iron wheel {20} up against 120 cogs; this wheel is fastened to the shaft of the lower attracting cylinder {15}. Consequently, when the threshing cylinder makes 233 revolutions a minute, the attracting cylinders complete 21 1/3 {revolutions], and with a diameter of seven inches, they

+ The term "attracting" {*uvlekatel'nye*) cylinders has also been translated alternately as carrier or conveying cylinders.

drag [p. 291] 22 inches of straw through; the straw gets one blow from one swingle for each half-inch of its movement passing through.

Cylinders 14 and 15 are made of beechwood and have furrows 2/3 of an inch deep along the entire length of their surface. These furrows prevent the straw from sliding as the swingles strike. While the straw is beaten by the swingles, it is strongly warded off from below and is drawn upward by the attracting cylinders. In all English machines the attracting cylinders are cast-iron and are from 4 to 8 inches in diameter (7" and 8" cylinders are used for lightness, if their interior is empty). After I proposed that wooden ones are also good, and much cheaper, Mr. Dombasle accepted my idea, and indeed the entire difference consisted only of the fact that a cast-iron cylinder, being heavier than a wooden one, would be more likely to bolster [support] itself.

The upper cylinder {14} should be raised according to the thickness of the straw passing underneath it, and for this the ends of its axle go in the section described as an arc from the center of the threshing cylinder's shaft {9}. But In order to increase at will the pressure of this cylinder on the straw, two levers rest {22, figs. 2 & 3} on both ends of its axle, and upon [292] them an attached balance-weight {23} moves back and forth for this, This action takes place somewhat like that on a Cantar or a Roman spring-balance.

In many English machines only the lower attracting cylinder is set in motion, which, if there is no straw between the two cylinders, turns the upper cylinder with its force by catching hold of its furrows with its own; whereas during the threshing process itself the straw, passing through both of them, produces this. In other [machines] motion is transmitted to both cylinders by means of a pinion fastened to the shaft of the threshing cylinder across from pinion 9 as it catches hold of the wheel placed on the axle of cylinder 14 from the opposite side of the wheel {20}. This wheel and the pinion can serve as two blocks [pulleys] and as an infinite rope [or cord], laid crosswise, as I have done myself.

The straw, held back by the attracting cylinders, is beaten by four swingles {10, fig. 4}, which are bars made of strong oak, three inches thick and lying this much higher than the threshing cylinder or the drum; the part of them that acts upon the ears is covered with an iron strip, so that the straw won't be crushed.

In [293] the machine of Mr. Molard, called the Swedish [machine], as in many of the English machines, as many as 12 such bars are found on the drum; in others, six or eight, etc. But there are no more than four in the machines built in Scotland. The kernels are beaten out of the ears thanks to the speed whereby they are each struck by swingles, and if this velocity reaches 2194 feet per minute, as it does in this case, then four bars are enough. Twelve swingles alone would increase the friction and resistance without bringing any real advantages to the threshing process. Even with the four swingles it cannot produce any better.

The space between each bar is covered with planks {24} which form a drum at both ends, on which iron hoops are fitted, and in this way all of this part is consolidated together. Without this precaution I had one threshing cylinder break apart.

In all threshing machines, depending on how straw is inserted, a concave surface {25} is added on, above or below the threshing cylinder. This forms an arc for about a quarter of the drum's circumference, with furrows inside [294] and placed in such a way as is evident in #25, figure 4. The vertical part of these furrows is one inch deep and lined with iron sheet so to it is not damaged by friction from the straw, whereas the diagonal part is 1.8" and without iron.

In the threshing machine described by Orel [O'Reilly?] in *Lietopis' Iskusstv i Manufaktur* [Chronicle of Arts and Crafts], pt. 9, p. 180, the [above] mentioned furrows, which should be found underneath, are replaced by the grating [made] of bars, or laths of ash-wood one inch wide and two inches thick, one inch away from each other, between which the kernels pass through.

While looking over Mr. Molard's machine in Paris, which was fully assembled, yet at the same time not functioning, I concluded that the furrows {25}, during the threshing process itself, would soon become filled with kernels and thereby form a concave surface almost smooth, without bringing any extra advantage. When placed on top the furrows can never get obstructed or offer resistance from the straw. My observation allowed Mr. Dombasle to decide to place this part on top, as it was in Robert Brown's machine. But it seems that these furrows offer few advantages; for the ears come out of the [295] attracting cylinders already fully threshed.

The mechanic who made Mr. Dombasle's machine, who also constructed one for Mr. Hoffman in Nancy, left them out altogether, as is evident in figures 6 and 7. He substituted for them a smooth concave surface {from 26 to 27}, and {between 27 and 28} he put in a grating consisting of large sticks made of ash 1½" in diameter.

In order to move the swingles {10} closer at will to the ribbed surface {25, fig. 4}, the cushions [props] supporting the shaft of the threshing drum are fastened onto two wooden cross-beams, of which one can be seen in 51 & 52 {fig. 3}; one end of these cross-beams moves on a bolt {52}, and the other rises and falls by means of a wedge [or spike?] {51}.

The kernels and the straw are forcibly dispersed by the threshing cylinder toward the boards {29}, and are driven toward the six handles on the shaft of the rake {30}. This rake gets its circular motion by means of a infinite rope, or strap {31, fig. 2}, set on a pulley {32} 19" in diameter, and placed on a shaft {7}, and on a pulley {33} 30 inches in diameter, and fastened to the rake's axle. [296]

Iron teeth or points about three inches long, turned somewhat backward, are driven toward the outer side of the abovementioned boards {29}. These jam the straw together as it descends from the threshing cylinder and drag it easily through the grating {34, fig. 4}, which is made of 14 large wooden rolling-pins, each 1¾" in diameter, with six-tenths of an inch between each of them.

The kernels and chaff tumble through this grating, but the straw, being dragged through by the rake, falls along the sloping plane {35} and is tied up again into sheaves. One worker is enough to do this. The kernels and chaff pass through the grating {34}, roll down along two inclined planes {36 & 37}, and falling into #39 they meet a strong draft of air produced by the four wings {43} of the ventilator , or "sail," enclosed in the drum {44}. All the ends of this drum are open, as visible in figure 3. The draft [of air] passes into the opening {45} in the direction of the inclined plane {40}, and in 39, while going through the grating {34}, it separates the chaff and the small-sized, lighter straw into 42, the thin kernels into 41, and the solid, full kernels into 46. The inclined plane {40} can be raised and lowered more or less by means [297] of a rope wound around the shaft {41, fig. 3}, which is fastened by a wire-drawn wheel supporting it. The plane {40} will be tilted all the more, the less that the kernels should fall down along it, but these will be both the choicest and heaviest ones.

Judging by the speed of the rotating swingles {10}, one would think that with their centrifugal force they would toss away all the kernels and straw that come out from under the concave surface {25} toward the rake {30}, almost in the direction of the line {60} designated by points. But experience has shown that a sufficient amount of kernels fall between the board {61} and the threshing cylinder, and rolling down along the inclined plane {63}, they spill out of the machine.

If a few bits of straw fall onto the inclined plane {40} perpendicularly, they then get blown upwards by a gust of air and land on #41 and 42 . But if they should arrive on the plane with their tips against the flow of air, then they will roll down with the heaviest kernels into #46, thereby reflecting their very small surface. This inconvenience can be changed by the swingles striking from above, as is evident in [298] figures 6 and 7. For this reason I intend to refit my machine, which threshes from below, as does Mr. Dombasle's..

The ventilator gets its circular motion by means of an infinite rope {47, fig. 5), which passes through a pulley {47} 19" in diameter, located on a shaft {7}. This rope is turned by a cross and is laid on a pulley {48} set on the end of the ventilator's axle. This pulley has three grooves or orifices, of which the largest is 8½", and the smallest 5½" in diameter. The rope is placed through them so that it can increase or decrease the speed of the ventilator's circular motion.

A few kernels are tossed out by the force of the swingles {10} between the attracting cylinders {14} and the arc {25, fig. 4}, and to hinder their slipping away, a board {49} has been added in an oblique position. Number 55 is the cross-bar that goes into both sides of the structure, cut into the upper beams of the machine and securing its immobility this way. Two interties {12} connect all the stalls of the machine. The ground surface is # 56. The place where the machine sits did not permit raising it higher, and so [299] a depression {57}was dug out of the earth, 3½ feet deep, where the bag is placed at the bottom of the slope {46}. The place for a malt mill and a crushing mill is #58; #59 is the small millstone for pressing oil by scraping clover seeds.

I saw this machine in action several times. It threshes grain quite well, and much better than chains do. The kernels do not fall into the straw, although a few small bits of the latter do pass through with the kernels. The grain worked by this machine cannot be called completely clean, in a strict sense, for its complete cleaning is accomplished by a winnower. But there is not one kernel gone astray, as happens when threshing with chains or even machines with iron attracting cylinders that are large in diameter, and consequently overly heavy.

One cannot but observe that this kind of machine is huge. Its beams, or ties, are massive, for the threshing drum demands great solidity. This [kind] was first made by Mr. Hoffman from Nancy. Since then, according to the advice and personal observations of Mr.Dombasle, he [Mr.Hoffman] has built many machines, all of which have remained satisfactory. They are represented in figures [300] 6 and 7. I shall mention only those parts of them which differ from Mr. Dombasle's machine.

This machine beats from above; # 64 is a cast-iron strip fastened to a wooden diagonal bar as an axle; by this the ears are broken open once and for all. An obliquely placed board {65} catches the kernels that fall between the table-board {54} and the attracting cylinders {14 and 15} and directs their fall under the threshing drum onto the grating. This board can slant by means of a clamp {66} which is shaped like an epicycloids, rotating on a bolt, as is evident in the picture. And without being fastened tightly, it can even be removed, if one notices that the space between it and the cross-bar {64} gets too obstructed.

Mr. Hoffman replaced the concave, toothed surface {25} (found in Mr. LeBlanc's machine under the threshing cylinder) with a smooth surface {26 & 27} and an Orelliev [O'Reilly?; cf. text p. 294] grating which in a double curve links up with grating #25 [in figure 4}. This machine does not have its own wind-blower, but the dipper {67} made of cloth leads the grain along with the chaff into an ordinary winnower {70}, which many people own and [301] which in France costs no more than 30 or 40 francs. This winnower is set in motion by an infinite rope{74}, or strap, placed on a pulley which is consolidated at one of the ends of the threshing cylinder shaft. The entire machine is set in motion the same way that Mr. Le Blanc's machine is. Shaft #4, which is supposed to make 36 revolutions per minute, is simply set in motion , or [else] by means of a compound mechanism, the lower attracting cylinder {15, figure 7}. A cast-iron wheel {68, fig. 6} with 72 teeth is placed on the axle of this cylinder; it turns a pinion {69} with 12 teeth, placed on the axle of a threshing cylinder which makes 6 x 36 (or 216) revolutions per minute. The sides and top of the machine are covered with shutters, which can be opened at will. It all costs 1400 francs.

I propose to provide my readers the pleasure of describing the operations of a few good threshing machines which I have sketches of, along with the number of revolutions per minute attributed to each of them.

[302]	Diameter ('/")	Revolutions/min.	Speed (in ft.)*
1. Mr. Dombasle's machine is set in motion by three horses, which make 3¾ circles per minute.			
Attracting cylinders	7 inches	21	
Threshing drum with four swingles	3 ft.	233	1194
Rake		18½	213
Ventilator in the middle makes		79	537
In one hour it threshes 80 sheaves of rye, which makes 360 liters; and 100 sheaves of oats, which makes 8 hectoliters [about 10 bushels, and 23 bushels, respectively]			

* the speed of the ends of the swingles and of the fans of the wind-blowers.

2. Mr. Hoffman's machine, set up at Mr. Grandjean's at Remeril near Nancy {France}, is activated by two horses	Diameter (ft./in.)	Revolutions/min.	Speed (in feet)
Attracting cylinder	6"	36	
Threshing drum with 8 swingles	2' 9"	216	1866'
Rake		18	283'

In one hour it threshes 700 lbs of grain, but ordinarily it does 600 lbs, or 4 hectoliters [11.3 bushels]

3. Duke Raguzsky's machine, as engraved by Mr. Le Blanc in his [printed] collection of machines for agricultural use. It is rotated by two horses who make three circles per minute.

Cast-iron attracting cylinders	7"	21	
Threshing drum with 12 swingles	2' 8"	168	1408'

[303] Among all the machines known at present, this one has the slowest motion, does not separate kernels from straw, and is of the very simplest construction. Per hour it threshes 120 sheaves of rye into 25 lbs apiece, which makes 3125 lbs. of grain and straw [per 10-hour day, approx.]

4. The machine which I think has been copied by Mr. M. F.-E. Molard from the System of Agriculture, by Mr. Koch Holgam, is rotated by four horses.

Wire-drawn, cat-iron cylinders with vacuum	7"	30	
Threshing cylinder with 12 swingles	3'	250	2354'

How much it threshes is not described, but it operates with a force of 36 men. NB: One worker threshes 25 lbs of grain per hour, whereas this machine threshes 6 hectoliters per hour [900 lbs.; over 36 times as much].

5. Robert Brown's machine, in his work entitled *Treatise on Rural Affairs*, beats from below and is water-powered.

Water wheel rotates per minute		6	
Wire-drawn, cast-iron cylinders	4"	24½	
Threshing cylinder with 4 swingles	4'	216½	2720'
Rake with four handles		14	175'
Wind-blower		270 2/3	

Per hour it threshes 75 bushels of oats and 40 bushels of rye. A bushel of rye weighs 60 lbs, which makes 2400 lbs of rye altogether, or 16 hectoliters. Mr. Brown adds that in England a small machine can be built for 1200 francs [*sic*], one that is rotated by two horses and which will thresh and winnow per hour six hectoliters of oats and three hectoliters of grain [wheat]. He notes that the best threshing machines are set in motion by six horses.

6. Mr. Gray's machine, in his publication entitled *Experienced Millwright*, is water-powered. In this machine, all parts move much faster than in the ones previously [discussed].

Large wheel		11½	
Wire-drawn, iron cylinders	5'	84	
Threshing drum with 4 swingles	3'	331	3117'
Rake with six handles		63	937'
Wind-blower		231	2648'

Per hour it threshes 2400 lbs of rye, or 16 hectoliters [45 bu.]. The author claims that the threshing drum makes at least [p.305] 300 revolutions a minute, and that the straw passes underneath it.

Machine No. 3, made according to a Swedish model, as designed by Mr. Le Blanc and as put in operation by Duke Raguzsky at Chatillon-sur-Seine, and at Fruare, near Nancy, by Mr. Dechant, has served as a model for all those made in France up to now. It is of the very simplest construction; it threshes the grain but does not separate it from the straw.

Mr. Hoffman's machine [No. 2] {figs. 6 & 7} constitutes a second level, whereby the straw is set aside. Mr. Dombasle's machine [No. 1] represents the third and latest level; here the grain is winnowed out as well. In this respect, I consider it necessary to remark that Mr. Hoffman's machine, it seems, is more attractive than all the others for the ordinary agriculturalist because, as a convenience, the winnower {70} can be joined to the cloth dipper {57; [67?, cf. p. 300]}.

The published works all agree that, according to countless careful observations, the very best thresher with chains lets one-twentieth of the kernels remain in the straw, but with a machine's actions the kernels are all retrieved and fewer of them are broken. In this part of France the action produced by this machine is [306] called "*chauber la paille*." This consists of beating the straw by hand over a barrel or a brake, whereby it gets much smaller and becomes more conducive for bundles, fascicles, mats, or for tying grapes onto stakes. Also, if you want to get clean seed-grain, and to separate the tares and other bad seed, you need only remove the board {54}, lift the upper wire-drawn cylinder {14}, and manually set a bundle of straw with the ears facing the drum, and in one second they will be threshed clean.

If the hay should be dusty or, in a low place, covered with slime from flooding, then there is no better way at all to clean it than to run it through this machine.

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This description has been provided by Mr. Valcour at the request of Mr. Dombasle during his illness. When he recovered, he added the following addendum.

[p. 307] Addendum to a Description of the Threshing Machine

The detailed description of this machine, given by Mr. Valcour, needs no amplification. But I consider myself obligated to present a few remarks which I have assembled over the past two years, carefully observing the progress and operations of this machine so important for agriculture. First off, I caution those who are engaged in constructing its main parts; then I will show the results that can be expected from the use of this threshing machine.

The wire-drawn cylinders of my machine are wooden and were made only for the time being, for I had thought to replace them with cast-iron ones, if experience showed me the need to change their diameter or the size of the cogs. But now I have fully given up my intention of changing them, and I prefer wooden ones to iron ones for the following two reasons. First, the kernels are not crushed, at least I saw nothing like this with my machine [308] at the time, since some of those who use iron cylinders in their machine complain about this. Although they often attribute this to the action of the swingles, I rather think that this [crushing] results from the pressure the kernels experience as they pass between cylinders made from a substance as hard as iron. Secondly, when using the wooden cylinders, it is possible, when needed, to increase or decrease the pressure of the upper cylinder by means of levers with gears; this cannot be done with iron ones. Moreover, the wooden cylinders, if well made, can work for quite a long time,

The threshing drum which I have has only four swingles, i.e. four bars with iron tips, which do the threshing. Almost all other machines made in France have twelve, and Mr. Hoffman, who built his machine on my model, decided to set up eight of them. I cannot believe it would be useful to utilize more than four swingles. Day-by-day experience proves to me that this number is enough for all the kernels to dislodge completely clean from the ears, if only the drum rotates with [309] great speed. This condition is necessary, no matter how many swingles there are, if you want to thresh successfully.

The straw which exits from my machine is quite intact and is less crumpled than if it had been threshed with chains. A large amount of rye and wheat ears appear intact, and should be examined up close, and even felt, so as to convince one that not a single kernel is left inside.

The concave, furrowed surface that covers part of the drum, against which the threshing takes place, I have set on the drum's upper side because this part of it turns from bottom to top. It would be useless to explain the reasons that forced me to adopt this arrangement, which overall is so widely used in England.

But I found out that it has a disadvantage I had not foreseen. I had supposed that all the kernels and straw would be very easily tossed toward the rake, due to the speed of the drum's movement. But experience has shown that despite all precautions, less than half of both kernels and straw fall under the drum. Therefore [310] I was forced to place an inclined plane here, leading all of this under the floor {53}, a rather minor inconvenience, however.

It is quite easy for straw to get flung to where it is ejected from the machine by the rake, and a small quantity of unwinnowed kernels is strewn onto the prongs [fans] of the rake, and thus are subject, along with the other [kernels], to the action of the wind-blower

However, this manual work can be considered extraneous to the action of the mechanism [of the machine]. In other machines Mr. Hoffman has built, the concave surface is placed below the drum and the latter operates from top to bottom, which I consider best. For both kernels and straw are all completely carried off to the grating and are subject to the action of the rake, which separates them.

To me it also seemed possible to eliminate the furrows on the concave surface, and to make it smooth and even much shorter. For I noticed that after the ears had passed between the cvlinders, they were completely threshed before reaching the end, and the furrows on [the surface] only significantly increase the resistance. And indeed, this rightly concerns those ears which are left on their stalks, for these [311] are held back by the wire-drawn cylinders and move forward only gradually enough for all their kernels to be beaten out. But the ears can be broken off by the speed and force of the blows from the swingles, one after another. They don't yet have time to be threshed, and the kernels are drawn out of them [the ears] only during their passage between the drum and the above-mentioned furrowed surface.

The circular rake, which separates the straw from the kernels [at] the grating, through which the kernels pass with the chaff, and the winnowing apparatus, which blows away the chaff, are parts which distinguish my machine from similar ones built so far in France. In constructing them I was guided by the designs of the best machines known in Scotland. Until now we have been satisfied in France with threshing machines made along the lines of ones from Sweden, where they were taken from Scotland in their original simplicity, before the more recent improvements were invented.

The addition of a circular rake and of other parts, set up to distribute various products of the harvest, is an important [312] improvement not to be minimized, except in machines quite small in size. This addition presents two advantages. First, it calls for one less worker, who, with the Swedish machine, is supposed to rake away the straw, so as to separate it from the kernels, to mix together the kernels which have been scattered all over the floor, and to winnow them.

Secondly, the need to place the Swedish machine in a covered setting, so that the kernels tossed too far away are not lost, leads to major inconveniences caused by thick dust in a covered threshing barn (*cabinet batteur*). This dust is not only quite uncomfortable for people remaining around the thresher for awhile, but it should be quite harmful for those who work with the machine. Above all, this dust settles on the straw, thereby making it less attractive as cattle fodder, and the kernels which exit the machine are soiled and sticky, which reduces their market value.

On the other hand, the Scottish machine can be set up not only inside a sheltered structure, but even under a simple overhang. For not one kernel will skip away. Dust is hardly affected by the action of the swingles and of the [313] wind-blower or sail, since kernels and straw are held back by the circular rake, and the kernels come out clean and sorted.

Some people have found the mechanism of my machine too complicated. Indeed, the addition of a rake and of the wind-blower has made its size four times larger than the Swedish ones. Both height and breadth have been doubled, and it was also necessary to add gear wheels (*engrenage*) and pulleys, so that the infinite ropes could transmit motion to the various parts separated from each other.

Thus, one cannot but acknowledge the merits of the Swedish machine regarding its greater simplicity in structure. But in evaluating these merits in each machine, one should consider the actions it produces. If a machine should have actions identical to another's, but has a simpler mechanical structure, then it is without a doubt better than the complex machine. But if the addition of certain parts to a machine produces useful actions, abundantly remunerating the capital expended on the original construction, then one can say that the machine has been improved rather than made more complicated.

At present [314], of course, one should think this way, for the simplicity of the Swedish model, compared with my Scottish one, cannot diminish the cost, for example, of the latest four-horse machine, for more than three or four hundred rubles. But this reduction cannot compare with the advantages offered by the Scottish machine: in saving working hands, in preserving the health of workers, and in the higher quality of the straw and kernels.

Moreover, Mr. Dombasle [the present writer] calculates the daily work output from his thresher, and states that one might be quite mistaken in calculating if one should estimate production of this or of any other machine by the increased work over a few hours, whereby animals are forced [to work] for a short time, and not all day, without wearing them out and making them incapable of continuing the same work for days following. This is the usual reason for inexact records, and I try to avoid this by showing the results of the usual work done by my machine.*

[315] For a long time I harnessed only three horses to my machine, but then I saw I needed to add a fourth, so they would not get so tired. My machine needed four men: one to spread out the sheaves on the board in front of the cylinders; another to hand him the sheaves; one to tie up the straw into bundles, and for this a very handy experienced worker is needed for success at the job; and a fourth person is needed in the stables to drive the horses.

Perhaps I should not put out expenses on the thresher for the worker that ties up the straw, for this specialty work is not necessary, but I already ascribe the maintenance of all these four workers to my threshing expenses.

I estimate the average amount per hour of work for each horse as 120 liters [34 bushels] of wheat or 190 liters [54 bu.] of oats. The number of people per machine is identical with the number of [316] horses, and thus we can estimate here one man-hour of work. In calculating expenses for the upkeep of horse and worker, it turns out that the threshing of each hectoliter of wheat [i.e. 2.8 bushels] costs 33 kopeks, excluding interest [i.e. cost] from the capital used in building the machine and in expenses for it over the year, which together reach as much as 200 rubles [$90}. Thus, on a farm where a thousand hectoliters (about 500 *chetverts*) of kernels from all kinds of grains are threshed each year, each hectoliter comes to 20 kopeks, whereas threshing a hectoliter of wheat generally costs 53 kopeks. Of course, on a farm where no more than 500 hectoliters are threshed, threshing will cost more. But where there are over 1000 hectoliters, it's cheaper, for the interest [costs] from building and maintaining the machine will expand more or less to an amount of one-quarter of the grain that is threshed.

In general, large threshing machines are more advantageous than small ones, for with these and others the same number of workers is needed, and moreover, the friction overcome by the constantly moving action is truly less on the larger machines than on the smaller ones. [317] The English landowners, who have acquired great expertise regarding threshers, generally think that on a farm which can bear the expenses of a threshing machine with six horses, using a smaller one would not be justified.

According to Mr. Dombasle's calculations, threshing with chains would cost him twice as much as it would by machine. But this still leaves out the chief gain from a thresher. Long-term experiments and observations made in England and Scotland have shown that threshing by machine yields one-twentieth [5%] more kernels than the best and most careful threshing done with chains, and one-tenth [10%] more kernels, if the threshing was done carelessly with chains, which is much more usual, for rarely do workers take on the onerous task of cleanly threshing out the last kernels left in the ears.

In receiving an average amount, about one-fifteenth [7.5%], of extra kernels from his threshing machine, Mr. Dombasle calculates that if an average farm threshed 1000 hectoliters [2840 bushels] from various grains per year, and if the average amount paid per hectoliter is 15 rubles, then the profit from a machine that saves one-fifteenth [more] of the kernels will reach as much as [318] 1000 rubles, and the entire profit from it will be 1400 rubles [ca. 25 pounds UK], which comprises one-quarter and even one-third of the annual payment for renting such a farm in most of France.

If we can add to this advantage [the following]: that with a machine you can thresh grain in winter and in bad weather with domestic workers and horses, when the cost of their labor should be cheaper than at other times of the year; that with a machine, the owner is free from workers' deceptions and is free from fear of fire, which must be guarded against when threshing in winter by candle-light; that with the help of a machine, a large amount of grain can quickly be

[* Editor's note: This remark by Mr. Dombasle deserves to be seen througb testing new threshing machines, and not through calculating work output by machine through tests which last several minutes, and extrapolating this into hours, days and weeks. This is especially necessary with hand-powered threshers. Conversely, one can be mistaken in one's conclusions about the actions of threshers, and lead other inexperienced landowners into error.]

threshed, if the proprietor needs it, or else he is free to postpone threshing if he chooses, knowing that nothing will hold him back in this.

Considering all these advantages combined, we ought to agree, of course, that the inventor of the Scottish machine has rendered the greatest service to agriculture. For this, one man can only be praised, and the name of Mr.Meikle should be honored among all nations as much as it is in his native Scotland.

[+ Andrew Meikle (1719-1811), inventor of the drum threshing machine in 1784.]

[p.319] Supplement to the Preceding Articles

From the preceding articles we can extract several overall principles in determining the merit of each newly invented threshing machine. We have seen that the Scottish machine, as perfected by Mr. Dombasle, rectifies the following operations:

1. It threshes winter and spring wheat completely cleanly, without crushing or damaging the kernels; thereby one additional kernel per every 15 is gained, in contrast to a careful threshing with chains. This operation is performed by wooden attracting cylinders and a swingle with four beaters, and by a concave, serrated surface.

The attracting cylinders are set up by means of a gear, so that a thick layer of straw can pass through them, more or less. The diameter of the cylinders is proportional to the speed of the blows of the whirling swingles, and thus one can determine approximately how many blows each ear receives as it comes out of the wire-drawn cylinders, which press out the kernels from the ears as they are protracted.

[320] The concave, serrated board, which holds back the straw upon its exit from the cylinders, helps finish off threshing the ear by means of the beaters.

This is the *first* operation of the machine, one which properly replaces threshing with chains. It is very important to note that a worker pushing the straw into the cylinders can still do this more quickly or more slowly than can the other [process], but pushing the straw or loose sheaves, and the threshing itself, does not depend on the [worker's] volition or diligence, but on the adjustment and action of the cylinders and on the speed of the swingles.

The more improved the machine, the less it needs supervision by a worker and accounting for incomplete work.

2. Through the action of the circular rake the threshed straw is separated from the grain and tossed away from the machine, whereas the grain [kernels] passes through the grating together with the chaff and glume. This is the *second* operation of the machine, one which replaces removal of the straw from the threshing floor and sweeping it away with

brooms via the usual manual labor.

The *third* operation involves winnowing to obtain clean, threshed grain. As we know, special machines have been built for this, [321] but with Dombasle the winnower was joined with the thresher, and in this way, with the power of four horses and four workers on the improved Scottish thresher, the grain-threshing process has achieved both the separation of kernels from straw and the [subsequent] winnowing.

Presuming that this machine has one general merit above all others – the simplicity and ease with which it works – we can accept that Dombasle's machine can serve as a model for large landowners, where over 500 *chetverts* [1000 hectoliters, annually] are threshed in the harvest, for it is impossible to complete these activities which it performs with a smaller number of horses or workers involved. And you save more time by using it for the entire process of threshing and winnowing grain.

What shortcomings, or at least drawbacks, does this machine offer for agriculture?

a) It is expensive and consequently impractical for small-scale farming.

b) In performing the three above-mentioned operations, it is immense and complex, and consequently needs experts skilled in construction, maintenance, and repairs. Thus, in countries with few talented mechanics or where the iron components needed for threshers are hard to obtain, as for example in many provinces of Russia, the slightest damage to its mechanical structure would render it [322] inoperable for a long time. This is its second drawback.

c) These threshers thresh primarily seed grains, and for husk and pod products, such as peas, they are not so useful. The drawing cylinders crush the kernels, and they are then useless for sowing. And so for a newly invented machine fully or, more correctly, partially to replace an improved Scottish thresher, with the grain threshed and winnowed cleanly, quickly, and easily, it would *first* have to be cheaper than a Scottish machine, and consequently more useful and practical for smaller farms; *secondly,* be less complex and more agreeable and simpler in structure; *third,* it would thresh not only seed grain, but other husked produce without shattering the kernels. However, as for the theory of its main structural parts, the Scottish machine should, it seems, serve as a model for every newly invented thresher.

Not long ago two threshers were invented in Russia by Messrs. Veshnyakov and Chaplygin. In the following issue, my sketches and those of others will be printed. At that time by acknowledging these inventors in their wish to be useful to their country, landowners can express their opinions on the merits and drawbacks of these machines.

S. Maslov +

[+ Stepan Maslov edited Yegor Chernykh's last published article, "Stockraising in Upper California" {O skotovodstvie v Verkhnei Kalifornii}, which appeared in the anthology *Historical Survey of the Activities and Works of the Imperial Moscow Society of Agriculture* in 1846.]

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