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V. SYKORA

METHOD AND APPARATUS FOR CROPPING HOPS

Serial No. 419,560

Filed Nov. 18, 1941

5 Sheets-Sheet 1

Fig. 1.

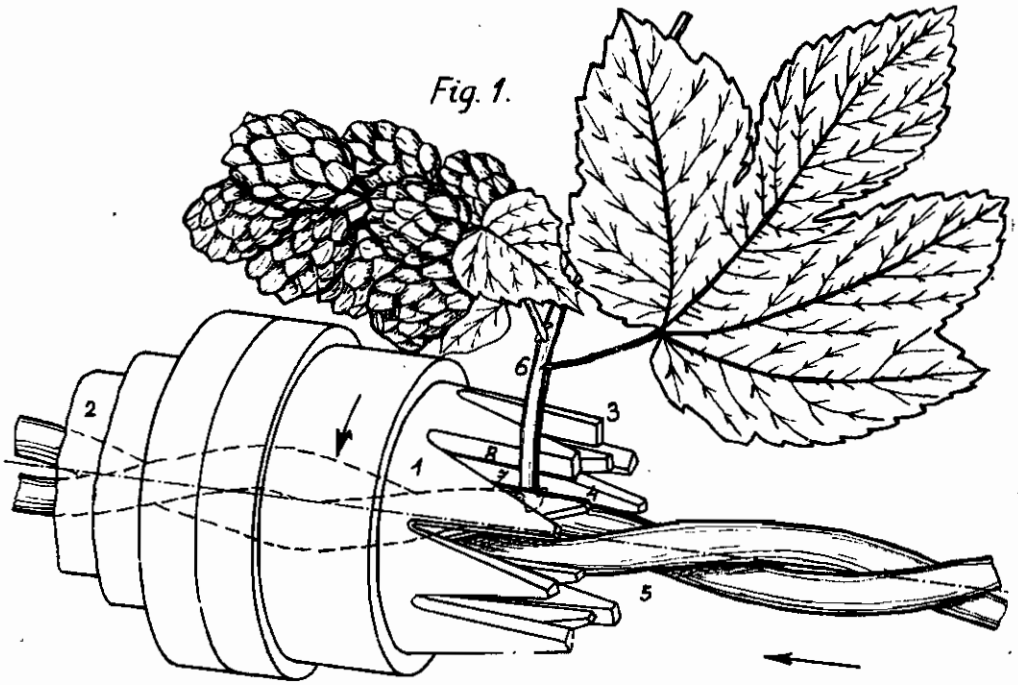

Fig. 2.

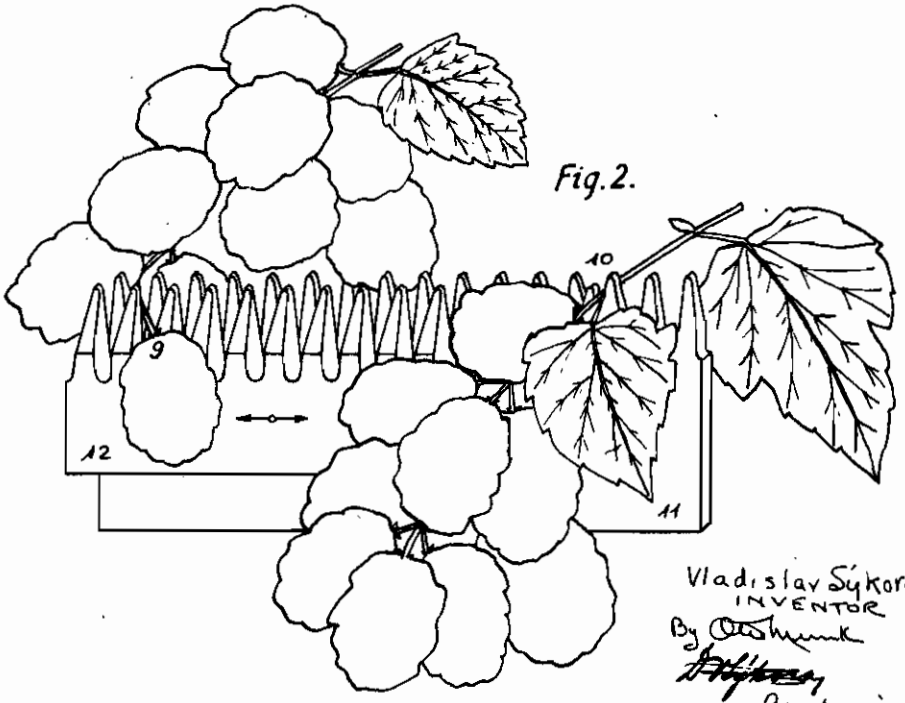

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Fig. 3.

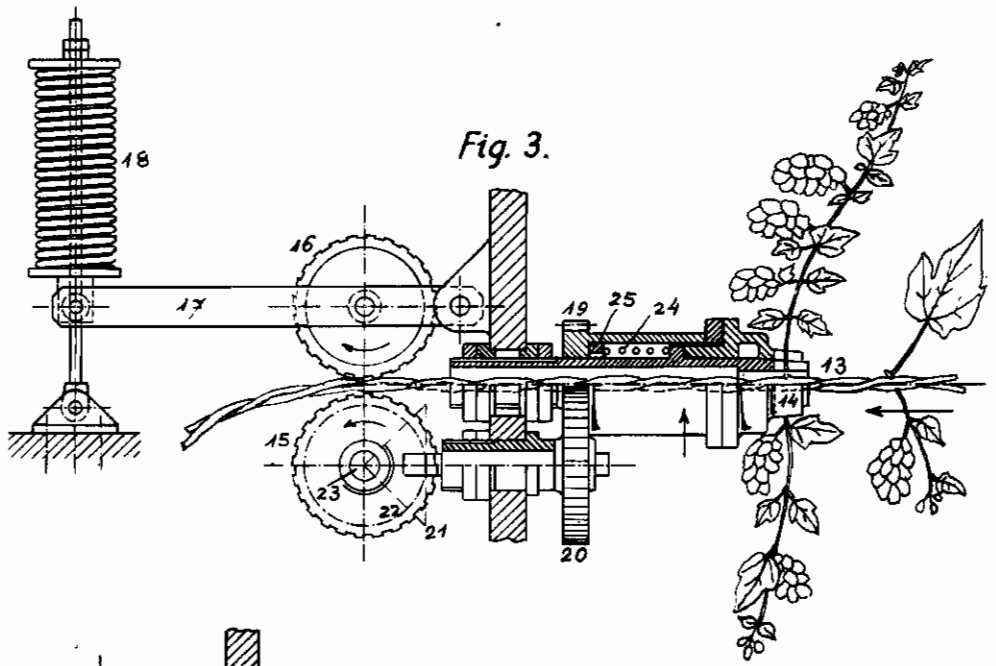

Fig. 4.

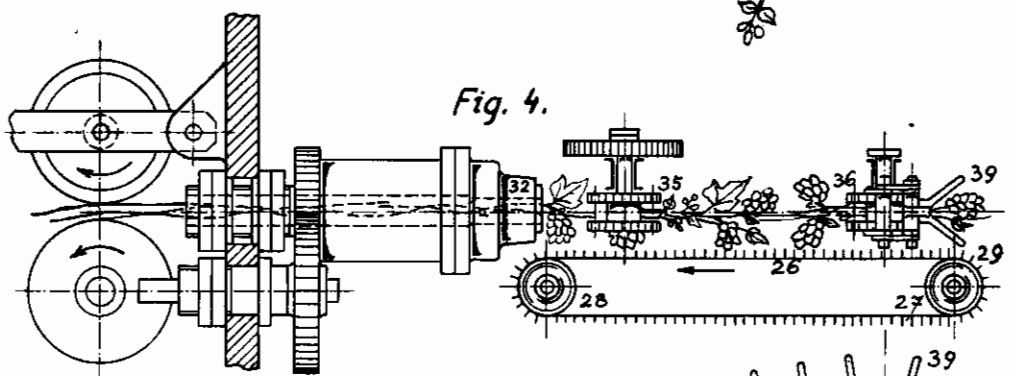

Fig. 5.

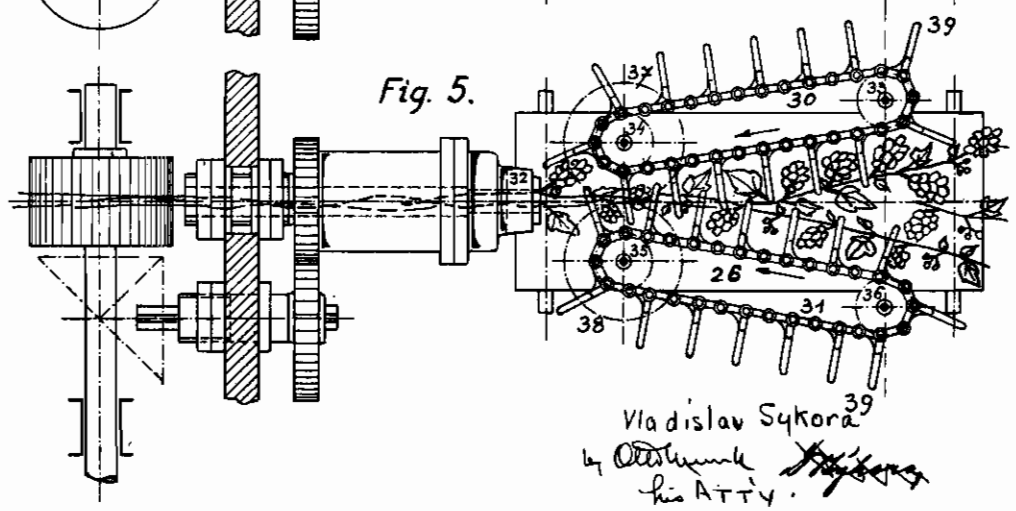

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Fig. 6.

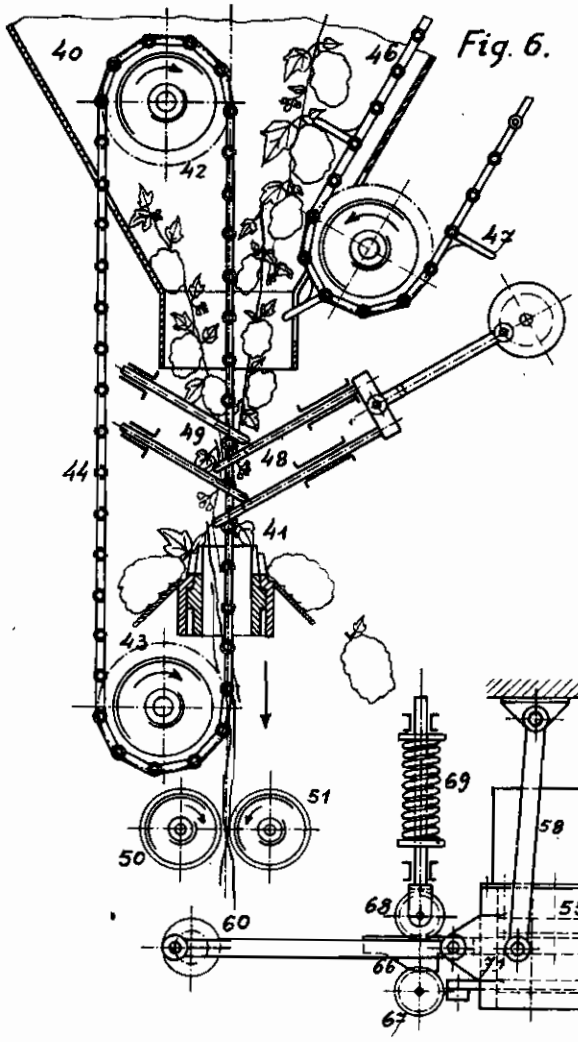

Fig. 7.

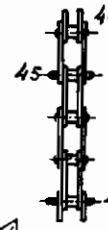

Fig. 10.

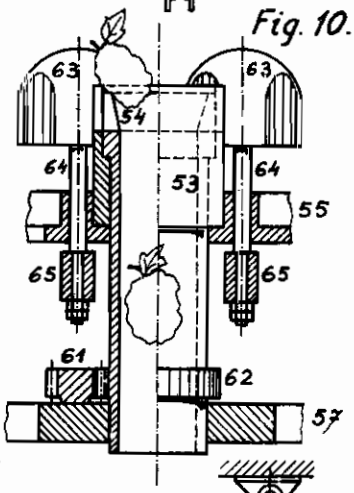

Fig. 8.

Fig. 9.

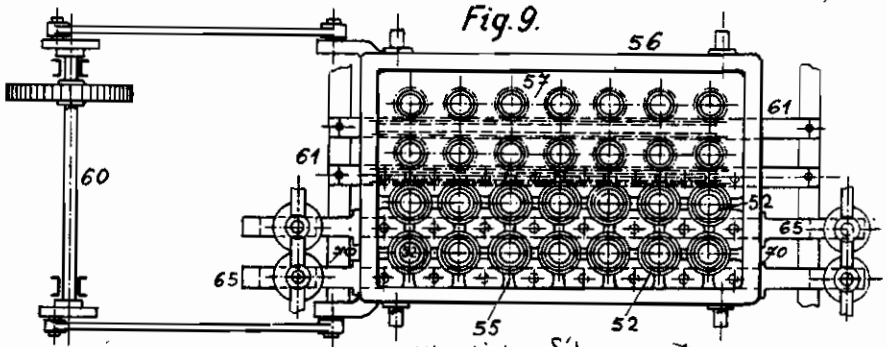

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Fig. 12.

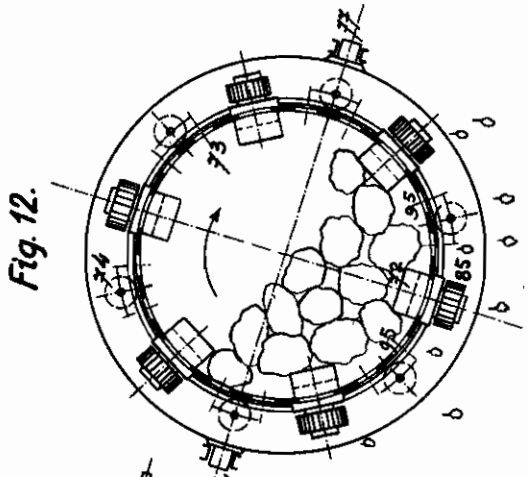
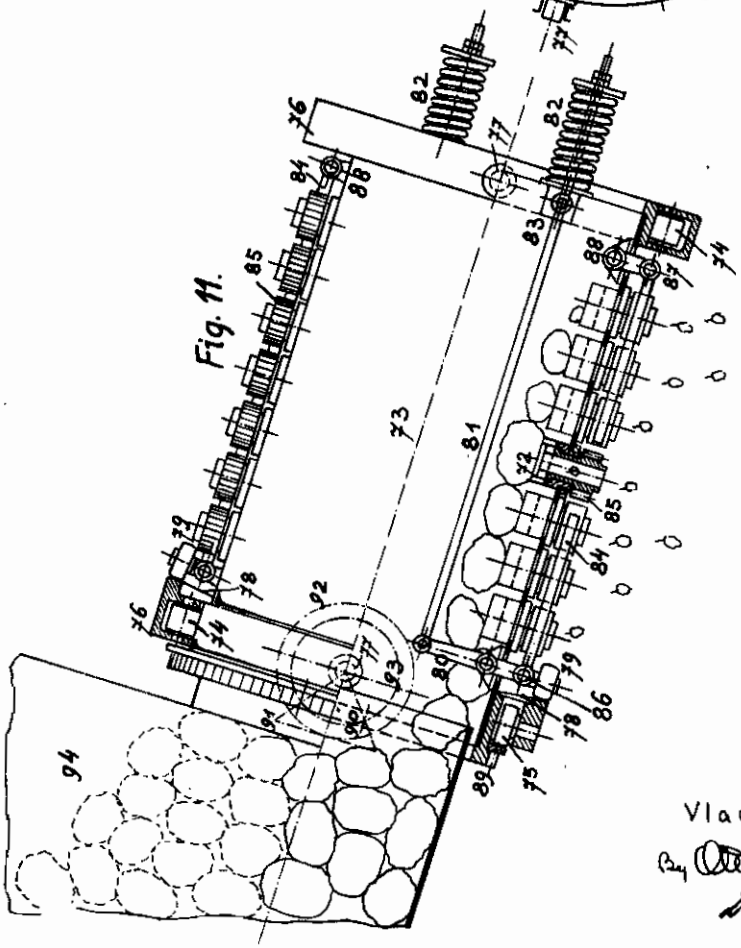


Fig. 11.



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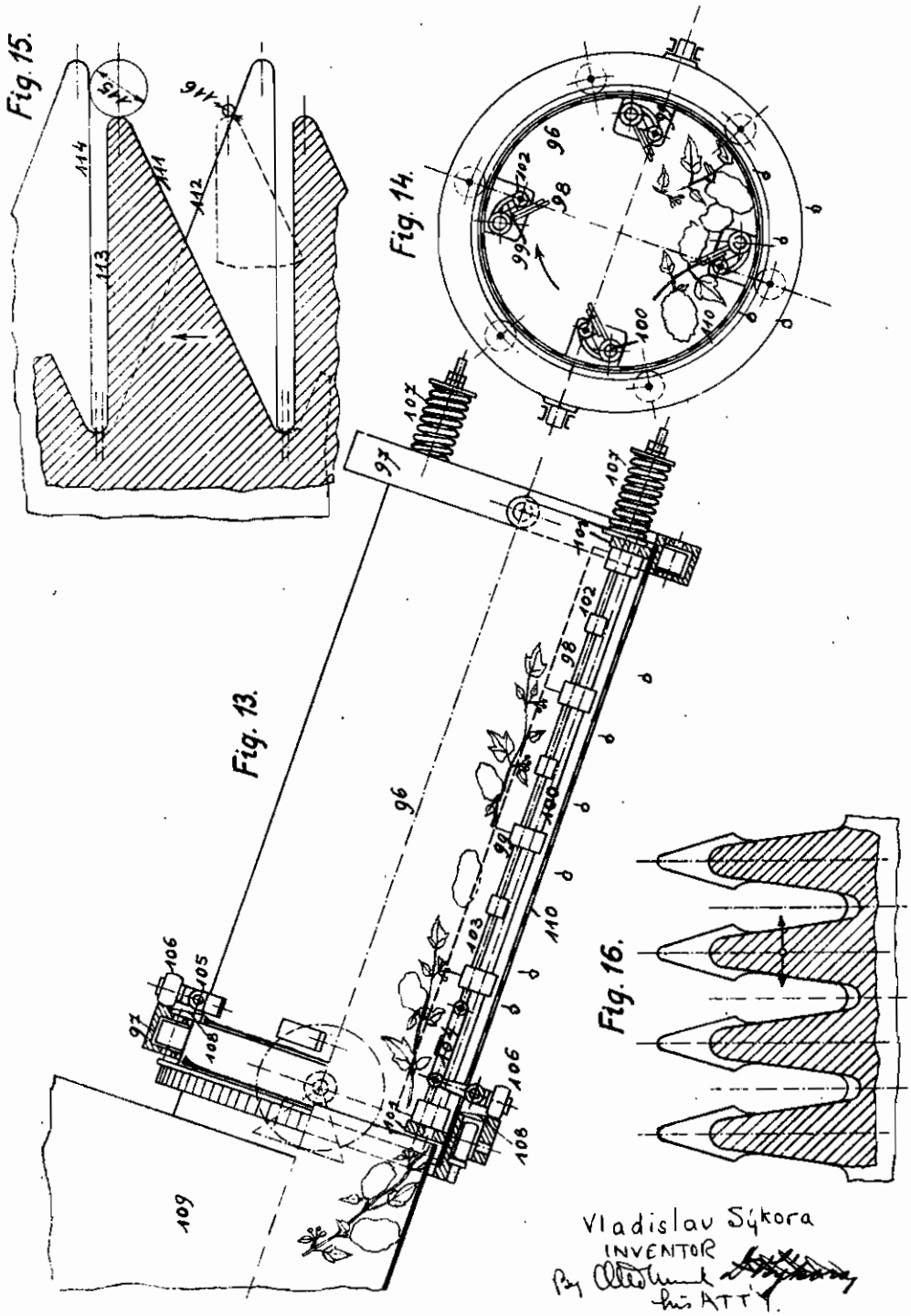
5 Sheets—Sheet 5



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ALIEN PROPERTY CUSTODIAN

METHOD AND APPARATUS FOR CROPPING HOPS

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Application filed November 18, 1941

There is a class of utility plants, the blossoms or the stalks and other organs of which are separately utilized. Alternately, two or more parts of the plant are used after their mutual separation. The most important of such plants is the hop and therefore only the hop will be referred to hereinafter. In the case of hops, the pistillate cones or strobiles, hereinafter referred to as strobiles, are utilized. However, the stalks of the hop plant may equally be utilized, e. g. in the textile industry. The leaves may be used as cattle feed.

Hitherto, the hop harvest has been carried out either by hand-picking or mechanically. In the case of hand-working, the strobiles are, as far as possible, pluck singly, thus leaving a small piece of stalk on each strobile, as otherwise the strobile would easily decay on being dried. Such plucking requires a great deal of labour hands which, moreover, can be occupied only during the short harvest season. Hop picking as pure hand labour is therefore very expensive. Furthermore, this working method is largely dependent on the weather prevailing and in the case of long lasting rains the hop can not be cropped in due time thus being depreciated.

The chief drawback of the hitherto used hop cropping machines consists in scraping the hop. The comblike parts scrape the individual strobiles. The stalks are easily torn off close to the strobiles so that the above mentioned decaying occurs on drying, the hop flour laying between the individual leaves of the strobiles is strewn out and the crop thus deteriorated.

The present invention consists in a mechanical shearing of the hop and offers, in addition to a high yield, the further advantage that the very important short stalk pieces as above mentioned, are undamaged on the strobiles. The method and the devices required therefor, being the subject-matter of the present invention, will be described hereinafter. The hop parts shorn apart may, as will also be disclosed, be separated from each other in a clean manner by known means and may then easily be treated for further use.

In carrying this idea of the present invention into effect it is preferable to proceed in three stages. First, the twigs are shorn off the hop stocks, thereupon the strobile bunches are shorn apart so as to form individual strobiles. Alternatively two of the above mentioned working stages may be combined to one single step. The resulting waste refuse consisting of leaves and stalks is removed by well known means, such as shaking, sieving, blowing out or the like. The stalks shorn off the hop stocks may be cut to a suitable length by well known devices and then bound into bales. This treatment facilitates their further utilization. Should wire pieces be included in the resulting refuse which would be detrimental in cattle feeding, such wire pieces may be removed in a well known manner by magnets.

The accompanying drawings, on sheets 1 to 5, Figs. 1 to 16 illustrate diagrammatically the method according to the present invention and, by way of example only, several embodiments of the devices for carrying such method into effect.

Figs. 1 and 2 illustrate in perspective the shearing process, Fig. 1 relating to the use of a ring-shear which will be described hereinafter, Fig. 2 to the use of comblike knives; Figs. 3 to 12 show diagrammatically several modifications of the three working stages of the method according to the present invention, Fig. 3 being a side view showing, partly in section, the separation of the hop twigs from the stocks with the use of the ring-shear, Fig. 4 a side view, partly in section, showing the separation of the strobile bunches from the twigs with the use of the ring-shear, Fig. 5 a corresponding plan view, Fig. 6 illustrating in a vertical section a somewhat modified proceeding in shearing the strobile bunches off the twigs with the use of a ring-shear, Fig. 7 a side view of a detail, Fig. 8 a side view of the ring-shear grate described hereinafter, for shearing apart the strobile bunches, Fig. 9 a corresponding plan view, Fig. 10 showing on an enlarged scale the vertical section of a detail thereof, Fig. 11 in a side view and section a modified proceeding in shearing the strobile bunches apart with the use of ring-shears, Fig. 12 being a cross section thereof, Fig. 13 a side view and section of a modification for effecting simultaneously two stages of the working process, i. e. shearing the strobile bunches off the twigs and shearing apart the strobile bunches by comblike knives, Fig. 14 a corresponding cross section. Figs. 15 and 16 show details, Fig. 15 being a portion of the developed cylinder projection of the ring-shear and Fig. 16 the view of a particular shape of the comblike knives. Referring to these illustrations, the method and apparatus according to the invention will now be described more fully.

Referring to Fig. 1. The telescopically arranged tubes 1 and 2 are provided with cutting prongs 3 and 4 on the one end. One of the tubes, in the figure the inner one, is fixed whilst the other, in the figure the outer one, is rotary. Both tubes may also be arranged so as to rotate

in opposite directions. This device will hereinafter be referred to as ring-shear. In 5 a plant organ, in the case illustrated a double-stalk of the hop stock, is introduced inside the ring-shear and drawn therethrough. The lateral plant organs, in the figure the twig 6 appear with their stalks between the cutting prongs and are shorn off. In Fig. 1, 7 indicates the fixed cutting prong acting in a straight manner, 8 the moved edge of the cutting prongs.

Referring to Fig. 2. The plant organs, in this figure at 9 a strobile, at 10 a strobile bunch, are shorn off by comblike knives 11 and 12. One of these knives, in the figure the knife 11, is fixed, whilst a reciprocated movement in lengthwise direction is imparted to the other knife, 12 in the figure, bearing against the fixed knife.

Referring to Fig. 3. At 13 the cut off hop stock is introduced inside a ring-shear 14 and drawn through rolls 15 and 16. The roll 15 is firmly supported and driven, the roll 16 is pressed onto the roll 15 by a lever 17 and spring 18 or the like. To facilitate seizing, the rolls may be provided with a surface fluting. Alternatively both rolls may be driven, the movement being transmitted from 15 to 16 in the simplest way by involute front wheels which are able to withstand the axial displacement occurring on the double-stalk of the hop stock being drawn through owing to its uneven thickness. For fostering the passage of the stalks and preventing their being squeezed in the case of an excessive thrust at one place only, two or even more pairs of drawing rolls may be provided. In the embodiment illustrated, the inner tube of the ring-shear is fixed, whilst the outer tube is subjected to a drive with a permanent turning direction. In this case, the drive is provided by cylindrical gears 19 and 20 and bevel gears 21 and 22 from the shaft 23 driving also the roll 15. By such combination of the ring-shear drive with the drive of the drawing rolls, the maintenance of a determined required ratio between the feed speed and the turning speed of the ring-shear may be obtained. A spring 24 which, under co-operation of an intermediate gliding ring 25 presses the outer tube of the ring-shear axially against the inner tube, enables the organs of the ring-shear to yield resiliently in the case of excessive resistances occurring.

Referring now to Figs. 4 and 5. The hop twigs fall on an endless belt 26 running over rollers 27 and 28, one of these rollers being driven and moving the belt in the direction indicated by the arrow. For fostering the twigs to be taken along therewith and for preventing them to move apart from each other, brushlike pins 29 are mounted on said belt. Two sidewise arranged endless chains 30 and 31 provided in a horizontal plane and being oblique relatively to the longitudinal direction are acting to press the hop twigs together and to introduce the stalks therof into a ring-shear 32. The chain 30 is laid over sprockets 33 and 34, the chain 31 over the sprockets 35 and 36. The sprockets 34 and 35 are coupled through front gears 37 and 38 and are driven. Individual chain links are provided with forks 39 the ends of which being rounded off to prevent the strobiles being stung through. Owing to the above mentioned coupling of the sprockets 34 and 35 any picking together of the forks is avoided on the twigs being pressed together. The forks seize the twigs which are conveyed along therewith and press their stalks together so as to introduce the latter into the ring-shear in the required position. In Fig. 4, for the sake of clearness, none of the chains is shown completely, but one chain link provided with a fork 39 being shown. The ring-shear with drawing rollers, drive, etc. is arranged in an analogous manner as described with reference to Fig. 3, only the cutting prongs being thinner and more closely together to avoid the strobiles being cut through. The strobiles and leaves shorn off fall laterally away.

Referring to Figs. 6 and 7. This modified embodiment of shearing off the strobile bunches consists in that the hop twigs arrive at the ring-shear 41 through a funnel 40. To prevent the funnel being choked by the twigs and to foster their feeding movement, an endless chain 44 laid over sprockets 42 and 43 extends with the one branch through the funnel and ring-shear axis and is provided with lateral spherically lugs 45 having the function of taking the twigs along therewith. One of said sprockets is driven. Such chains for facilitating the forward movement of the twigs may likewise be arranged sidewise on the funnel, as is illustrated in 46. In this case, the lugs 47 are set on individual chain links and may be of a greater length than in the above mentioned arrangement, since they have not to pass through the ring-shear. Alternatively, it is possible to provide both the axially extending and the lateral chains. The necessary pressing together the stalks of the hop twigs is operated in such case either as indicated in the Figs. 4 and 5 or by means of crank-driven forks 48 and 49 placed opposite each other in a similar arrangement as the chain forks 39. Owing to their obliquity, these forks exert, in addition to pressing the twigs together, a progressive movement with the twigs. In order to ensure a correct co-operation of the forks, the crank drives thereof are coupled together. The ring-shear 41 has thin cutting prongs to prevent the strobiles being cut through. The strobiles and leaves shorn off fall laterally away. The stalks may moreover be seized by rollers 50 and 51 of the kind referred to above for fostering the drawing through of the twigs.

Referring to Figs. 8–10. A number of ring-shears 52 are combined together in a ring-shear grate. Fig. 10 shows such a ring-shear on an enlarged scale. In this case the outer tube 53 is fixed whilst the inner tube 54 is rotating. The cutting prongs are thin thus preventing the strobiles being cut through. The fixed tubes of all ring-shears of the grate are inserted in a plate 55 of the ring-shear grate 56. The inner tubes are inserted within the fixed outer ones, so as to be easily rotatable and are moreover supported in a plate 57 of the ring-shear grate 56. Said inner tubes, by gravity, abut by a projection against a shoulder of the fixed tubes, thus being able to yield resiliently in the case of additional resistances to be met. The ring-shear grate is suspended on bars 58, and for fostering the feed of the strobile bunches strewn thereupon through a hopper 59, a reciprocating movement is imparted thereon by a crank gear 60. This shaking movement may likewise be utilized for the drive of the rotatable inner tubes of the ring-shears. To this effect, racks 61 attached to the fixed frame of the device are brought into mesh with a gearing 62 provided on the rotary tubes of the ring-shears. In such manner said ring-shears are exerting, on the ring-shear grate being shaked, an alternating rotation, the strobile bunches arriving on the ring-shears being thus

shorn apart and the individual strobiles thus formed falling out through the inner space of the ring-shears. To avoid the clearance between the ring-shears to be choked and to hamper the cutting operation to be carried out on the strobile bunches, gliding members 83 are arranged in said clearances, said members being topwise spherically limited and exerting a reciprocating movement parallel to the ring-shear axis. This movement may likewise derive from the shaking movement of the ring-shear grate 56. To this effect, rodlike extensions 64 of the gliding members 53 are firmly inserted in cross bars 85 exerting the necessary swinging motion on the ring-shear grate being shaken in such a manner, that endwise wedgelike projections 66 abut against fixed pulleys 67 onto which they will be pressed by pulleys 68 under the influence of thrust springs 69 or like elements. The cross bars 68 are guided within the ring-shear grate 86 by lateral lugs 70 thus taking part in its shaking movement and moving only up and down in vertical slots 71. Thus the strobile and other plant organs shorn are thrown from the clearances between the ring-shears into the inner space of the latter and discharged. In Fig. 9 the two top rows of ring-shears are illustrated in section above the gearing 82 whilst the two bottom rows are shown in a top view. Therefore, the upper half of this figure discloses the bottom plate 57 and the racks 61 whilst the lower half shows the top plate 55 and the cross bars 65. To prevent the strobile bunches strewn on the ring-shear grate to accumulate, a coarse screen may be provided on top the hopper 59 to ensure a correct spreading ing the strobile bunches.

The shearing operation may be enhanced by pressing the strobile bunches onto the ring-shears by the action of rods provided in the upwardly extending axis of the ring-shears and guided and driven in such a manner that they take part in the shaking movement of the ring-shear grate 56 and another swinging movement is imparted thereto in the direction of the axis mentioned above. The same effect may be achieved by a pneumatic pressure from above or by sucking from below. In such case the ring-shear grate must be sealed against the carrying structure.

Referring to Figs. 11 and 12. In this case ring-shears 72 are arranged in rows on the circumference of a rotating drum 73. The drum is supported in the usual manner endwise in rollers 74. The axial thrust of the drum is taken up by pulleys 75 arranged on the one end. Both the rollers and the pulleys on one end are arranged in carrier rings 76. To enable the inclination of the drum to be adjusted, said carrier rings may be supported in the machine frame by lateral pivots 77 the supporting arrangement for the one carrier ring being slidable. The ring-shears are arranged in a similar manner as described with reference to the previous modified embodiment. The alternating rotating movement of the inner tubes is derived from the drum rotation. To this effect, one of the carrier rings is provided laterally with a corrugated lug 78 against which pulleys 79 provided on levers 80 are pressed by tie-rods 81 and springs 82. The levers 88 are supported on the drum circumference, the springs abut against the articulated bearing arrangement 83 of the tie-rods 81. Racks 84 being in mesh with a gearing 85 of the inner tubes of the ring-shears are linked at 86 to the levers 80, at the other end in 87 to the levers 88 supported likewise on the drum circumference. On the drum being rotated, the levers 88 exert a swinging movement and the racks 84 swinging therewith impart an alternating rotating movement to the inner tubes of the ring-shears. The drum rotation is effected through a gearing 88 provided at the one end thereof. In the case of adjustable drum inclination the drive will be preferably led over one of the carrier ring pivots 77. The gearing 89 is in mesh with a front gear 90 connected fixedly to a bevel gear 91 being in mesh with another bevel gear 92 being in turn fixedly connected to the front gear 93 taking up the outward drive. The gears 92 and 93 are supported at one of the carrier pivots 77.

Through a funnel 94 the strobile bunches are led inside the drum to roll down the ring-shears thus being shorn into individual strobiles. The strobiles and other parts shorn off are discharged either through the inner space of the ring-shears or through sievelike holes 95 provided in the drum jacket between the ring-shear rows.

Referring to Figures 14 and 13. With this arrangement shearing the strobile bunches from the twigs and shearing the bunches into individual strobiles, i. e. two of the steps of the whole working process may be combined in a single step. A rotating drum 96 of eventually adjustable inclination is carried, similarly as in the previous case, in carrier rings 97 and driven by gears. Inside a series of comblike double-shearing shears 98 acting like those described with reference to Fig. 2 are arranged, the pitch of said shears being such as to enable them to cut through the stalks but not the strobiles. The fixed shearing combs are fixed on carrier rods 100 by means of bearing members 99, said rods being pivoted in shields 101 fixed inside on the drum circumference. On these fixed combs the moving shearing combs are abutting, being guided in bearing bodies 99 and reciprocated by driving cams 102. These cams are fixed on rods 103 supported in the bearing bodies 99 and operated through links 104 from levers 105. These levers are supported on the drum circumference and provided on the one end with pulleys 106 which are pressed against the corrugated lateral lug 108 of one of the carrier rings 97 through the action of springs 107 mounted on the rods 103 and abutting against the shields 101 at the one drum end. In this manner the necessary reciprocating movement of the shearing combs is derived from the drum rotation. The comblike shearing knives are inclined under a suitable angle relatively to the drum radius and project inwardly to a suitable height, eventually some of them more and others less so as to seize all the strobiles sitting on the twigs in various positions.

Through a funnel 109 the hop twigs are introduced into the drum and roll down the shearing combs on the drum being rotated, this leading to a progressing shearing off the strobile bunches which in turn are shorn into individual strobiles. The latter falls through sievelike holes 110 provided in the drum jacket. The stalks and large leaves are discharged through the bottom space of the drum. Alternatively, series of ring-shears such as 72 in Fig. 11 may be arranged at the drum circumference between the comblike shearing knives 83 of this device, the strobile bunches being shorn from the hop twigs fed into the drum by the comblike shearing knives whilst the shearing of the strobile bunches into individual strobiles is enhanced by the ring-shears.

Referring to Fig. 15. In their pronged portion, the tubes of the ring-shears may be conically or cylindrically arranged, any axial thrust having to be taken up by suitable shoulders.

In a conical arrangement with the apex of the cone being directed against the passage direction as in Fig. 1 the device causes the parts to be shorn to be drawn apart in the required manner, thus loosening the material to be drawn through.

The drawing through is further facilitated in making the diameter of the inner ring-shear tube close behind the cutting prongs somewhat larger than in the region of the cutting prongs, as is shown in Fig. 3, so that a widening of the cross section is attained in the direction of the passage.

In the case of ring-shears, the rotating part of which turns only in one direction, the cutting edges of the prongs are to be arranged in axial planes thus avoiding any counterpressure occuring otherwise on inclined cutting edges.

The most favourable cutting conditions are attained in the arrangement shown in Fig. 15 showing a developed cylinder surface whereon the cutting prongs have been radially projected. The mobile cutting prongs are hatched in this figure. The following principles must be observed.

The ratio between the passage speed in an axial direction and the rotating speed in a tangential direction is firstly to be chosen in such manner that the tangential speed is larger than the tangential component in the opposite direction and which may be calculated, presuming also the rotatable tube of this ring-shear to be motionless and supposing the stalk to be cut while gliding on the oblique non-cutting and therefore blunt flank 111 of the actually rotatable tube, and determining the respective tangential component as an effect of the axial speed. Thus, during the movement, the blunt flank glides off the stalk to be cut always faster than any accumulation of the stalks could occur between the blunt edge considered of the moved tube and the respective edge 112 of the fixed tube. Thus, with this arrangement, only the axially extending sharp cutting flanks of both knives 113 and 114 are effective.

The width and depth of the clearance between the cutting prongs of both tubes are to be chosen in such manner that even with a most unfavourable incidence of the stalks to be cut, these latter are always cut through yet before they would be able to get to the bottom of the clearance.

It is to be understood that, on the inlet, the gap must be larger than the largest occurring diameter of the stalks. Further there are to be investigated the two limit cases of the various possibilities of the stalks arriving at the gap and the conditions are to be in conformity with the results. One of those limit cases is the arrival of the stalk alongside the fixed cutting edge 114, the other the arrival alongside the fixed oblique and blunt edge 112. Both these limit cases are illustrated in Fig. 15. In the former case the maximum occurring stalk diameter 115, in the latter case the minimum occurring diameter 115 must be taken into account.

In both cases, the most unfavourable case must be presumed, viz. the stalk arriving in the inlet just on the blunt point of a cutting prong of a rotatable tube, so that the next following cutting flank concerned requires the longest imaginable time for attaining, and cutting through, the stalk under treatment.

Thus, the absolute value of the passage speed is without any influence on the correct cutting operation. Only its correct ratio relatively to the rotating speed in the sense explained above is decisive.

This independence on the passage speed enables very high cutting outputs to be attained.

Referring to Fig. 16. To prevent stalks introduced between the shearing combs to fall out, the cutting prongs of both shearing knives i. e. the fixed and the reciprocating ones, are arranged according to Fig. 16. The moved cutting prongs are hatched. The fixed cutting flanks are tapered thus acting as a kind of barbed hook.

It is to be understood that all the driving devices have been designed and shown in the figures merely by way of example and may obviously be replaced by other known devices acting to the same effect, e. g. the racks by chains, etc.

The transport between the individual parts of the apparatus is carried out by known means, such as conveyors, bucket-elevators, pneumatically and the like. The whole plant may be driven by a motor of any kind. This motor may also be used for propelling the carriage whereon the apparatus is to be transported.

Since the above disclosed method allows of shearing off all strobiles from the top stocks and as on removing the refuse only those strobiles which are too small to be utilized are eliminated, such cropped strobiles include also those of inferior quality which may be recognized on their brownish colour unlike the green or yellow-green strobiles being of high grade quality.

This unsuitable strobiles may be eliminated by hand-picking e. g. on a belt whereon the strobiles are conveyed or automatically in a known manner by using photocells.

The three working stages above described may be united in a single machine mounted eventually on a carriage to be preferably portable or may be preferably be carried into effect on two machines, one of which being arranged for shearing the hop stocks and twigs, the other for shearing the strobile bunches into individual strobiles and for separating the strobiles from the refuse material. Such division has the advantage, that the first machine can be smaller and lower so as to move easier through the hop yard thus facilitating the hop stocks to be approached. The other machine may be erected close to the hop drier. The mixture of strobile bunches and waste delivered by the first machine can be brought to the other machine in the well known hop carts.

It is also possible to design the plant in such manner that the mixture from several machines is conveyed to a common machine for shearing through and separating the waste.

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