GEOLOGICAL SURVEY OF KENTUCKY.

N. S. SHALER, Director.

CULTURE OF FLAX AND HEMP.

PART II OF REPORT ON THE HISTORY, CULTURE AND MANUFACTURE OF FLAX AND HEMP.

BY JOHN R. PROCTER.

HEMP BREAKING IN KENTUCKY.

CONTENTS.

PREFACE.

As the representative of Kentucky at the International Exhibition at Philadelphia in 1876, I made a study of such exhibits as would, in my opinion, most advance the best interest of the Commonwealth, by bringing to the notice of its citizens the results of the observations. Among other subjects, I gave attention to flax and hemp, with a view to the encouragement of the culture and manufacture of those fibres in Kentucky, embodying the results of my study in a report on the "History, Culture and Manufacture of Flax and Hemp." The present high price of those fibres, and the large prospective future demand, has elicited much inquiry from the agriculturists throughout the State, and has induced his Excellency, the Governor of Kentucky, to order the publication of Part II, devoted to the culture of flax and hemp, in advance of the publication of the entire work.

Under the system of social economy existing before the application of steam as a power, and the great improvements in machinery, the raw materials were manufactured by and among the producers of the same. Thus Egypt was the great flax-producing and linen manufacturing country of ancient times; and Belgium, Ireland and Russia of more modern times. So in America, prior to 1850, the flax and hemp was manufactured among the people who produced it. In 1850, out of a total of 7,709,123 pounds of flax grown in the United States, Kentucky produced 2,100,106 pounds, all of which was manufactured at home; and so with the large production of hemp, most of it being manufactured within the State into cordage, bale rope and bagging. From causes which are discussed at length in that portion of the report devoted to the history of flax and hemp, the manufacturing of those fibres went beyond the State, flax culture has been almost abandoned, and the production of hemp greatly decreased. Indications of late years point unerringly to the fact that there must come about a re-distribution of manufacturing, and that those localities producing the raw material and cheap food, other things being equal, must do the manufacturing. Kentucky, by its central position, cheap power available, and advantages of climate and soil, is pre-eminently fitted for the manufacture of flax and hemp, and desirable results may be expected from the co-operation of the intelligent agriculturists of this State.

FRANKFORT, February 25, 1880.

that an acre would yield two tons of straw, one fourth of which would be fibre, he found the amount of inorganic matter abstracted from the soil by the fibre to be *six pounds per acre.* According to the analyses of Sir Robert Kane, M. D., one hundred parts of the ashes of the entire flax-plant are composed of—

Potash	11.78
Soda	11.82
Lime	14.85
Magnesia	9.38
Alumina and oxide of iron	7.32
Phosphoric acid	13.05
Sulphuric acid	3.19
Chlorine	2.90
Silica	25.71
Total	100.00

According to the analyses of Sprengel, the inorganic matter in flaxseed is 2.340 per cent., consisting, in the 100 parts, of—

Potash	17.59
Soda	6.92
Lime	8.46
Magnesia	14.83
Oxide of iron	1.25
Phosphoric acid	36.42
Sulphuric acid	2.47
Chlorine	0.17
Silica	10.58
Total	98.69

Assuming the yield of an acre to be two tons of straw and twenty bushels of seed, each bushel weighing fifty-six pounds, the amount of inorganic matter abstracted from the soil will be—

In the seed	26¼ lbs.
In the straw	65¼ lbs.
Total	91½ lbs.

According to Johnston, a crop of wheat, at the rate of twenty-five bushels to the acre, will take from the land two hundred and ten pounds per acre of inorganic matter, as follows:

	In the Grain.	In the Straw.
Potash	7.15	22.44
Soda	2.73	0.29
Lime	0.85	12.09
Magnesia	3.63	6.87
Oxide of iron	0.20	2.35
Phosphoric acid	15.02	5.54
Sulphuric acid	0.07	10.49
Chlorine	. . .	1.97
Silica	0.35	117.94
Total	30. lbs.	180. lbs.

A crop of barley, of forty bushels to the acre, takes from the land—

In the grain	53 lbs. per acre.
In the straw	160
Total	213 lbs.

A crop of oats, of fifty bushels to the acre, takes from the land, in the grain and straw, three hundred and twenty-six pounds. A crop of turnips, of twenty tons, takes six hundred and fifty pounds of mineral matter from each acre of land.

Dr. Robert Peter, in an exhaustive chemical examination † of the tobacco-plant, gave, as the result of the analyses of thirty different specimens, the following essential mineral ingredients removed from an acre, in one year, by a crop of one thousand pounds of tobacco, and adding one third more for the stalks:

	Pounds.
Potash	69.73
Soda	6.80
Lime	*68.00
Magnesia	8.67
Phosphoric acid	8.13
Sulphuric acid	8.40
Chlorine	1.06
Silica	5.86
Total	176.65

* Equal to 121.17 pounds carbonate of lime.

† See pp. 84–87 and 298, Vol. IV (1st Series). Kentucky Geological Survey of Kentucky.

It will thus be seen that chemical tests prove that flax takes less of the mineral elements from the soil than either of the above staple crops. Chemical investigations of the hemp-plant, by Sir R. Kane and Dr. Robt. Peter*, prove beyond question, that whilst hemp extracts large quantities of organic matter from the soil, yet the materials so extracted are not found in the fibre, but in the stem, leaves, and the glutinous matter taken from the hemp by the retting process, and that "whilst an average crop of hemp takes only an amount of potash from an acre varying from less than one pound to less than one third of a pound, the wheat crop takes nearly five and a half pounds; the corn crop more than eight, in the grain alone, and the tobacco crop nearly seventy pounds; and while the hemp crop carries off only from one and a quarter to two pounds of phosphoric acid, the wheat will take more than nine; the corn more than eleven, in the grain alone, and the tobacco more than eight pounds." The truth of the above is made manifest by the experience of the hemp-growers of Kentucky. Hemp has been grown for a number of years on the same ground, in Central Kentucky, without a perceptible deterioration of the fertility of the soil.† It is well known, that when Egypt was the great flax-growing country of the world, it was also the granary of the world; and Belgium, where the relative acreage of flax is greater than in any other country, the fertility of the soil has been constantly improving for centuries. The reason of this, says Robert Scott Burn, is, "that flax cultivation involves good husbandry," and "flax cultivation and bad cultivation are quite incompatible."

Sir Robert Kane says‡: "The agriculturist should steadily bear in mind that the fibre, which he sells to the flax-spinner,

---

* See Appendix (B).

† One peculiar advantage attending the cultivation of hemp and flax is, that a crop of the former prepares the land for the latter, and therefore a crop of hemp is clear gain to the farmer. That these plants impoverish the soil is a mere vulgar notion, devoid of all truth. The best historical relations and the verbal accounts of honest, ingenious planters concur in declaring it to be a vain prejudice, unsupported by any authority; and that these crops really meliorate and improve the soil."—*A Dorsetshire Gentleman. Bath Society Papers*, 1781.

"It does not impoverish the land, but rather improves it."—*A Flax and Hemp-grower of "Many Years' Experience," Wisbeck, Eng.*

‡ Industrial Resources of Ireland.

has taken nothing from the soil. All that the crop took out of the soil he has still in the steep-water and in the chaff of the scutched flax, and if, after suitable decomposition, these be returned to the land, the fertility of the latter will be restored; and thus materials at present utterly neglected, and even a source of inconvenience, may be converted into valuable manures." The experiments of Dr. Robert Peter prove the same as to hemp: "We notice also that the removal of the hemp-herds (which are believed by some practical farmers to bear a proportion in weight to the hemp fibre of three to one) will take from the land greatly more of its essential ingredients than the hemp fibre itself; for, while the merchantable hemp holds less than a pound of potash, and two pounds of phosphoric acid in its composition, the equivalent quantity of hemp-herds holds more than four pounds of potash, and nearly three pounds of phosphoric acid." Dr. Peter deprecates the universal practice of burning the hemp-herds, and recommends composting them or spreading them over the land to rot. (See Appendix, page B.) It would seem, from the above, that the objections to flax, as an exhaustive crop, are not well founded.* Where grown exclusively for the seed, and the seed and straw removed from the land, it must be exhaustive; but it should be borne in mind that the oil-cake† made from the seed, after the extraction of the oil, fur-

* "The British farmer may study with advantage the peculiarities of that system which makes the Flemish farmer look upon the flax crop as one of the most important, and which, so far from robbing the land of its fertilizing properties, *adds, on the contrary, greatly to them*."—*An Agricultural Tour in Belgium*," &c., *London*, 1862: *Rob't Scott Burn.*

† From a series of experiments which I [Boussingault] undertook, in concert with Messrs. Dumas and Payne, it appears that all of the articles acknowledged to be most powerful as fatteners, are those that contain the largest proportion of fatty principles. The following substances contain the numerical quantities of matter soluble in ether in 100 parts:

Common maize	8.8	Meadow hay	3.8
Rice	0.8	Beans	2.0
Oats	5.5	Lentils	2.5
Fine bran	4.8	Mangel wurzel	0.1
Coarse bran	5.2	Carrots	0.17
Dry clover	4.0	Oil-cake	9.0
Dry lucern	3.5		

The following show the relative value of manures made from a ton (2,000 pounds) of different foods, from careful experiments by John B. Lawes: Cotton seed cake, $27.86; rape cake, $21.01; linseed cake, $19.72; lentils, $16.51; tares, $15.75; oats, $7.40; wheat, $7.08; Indian corn, $6.65; clover hay, $9.64; meadow hay, $6.43; oat straw, $2.90.

nished one of the best manure-making foods to be had; so that means are thus provided to keep up the fertility of the soil.

Another objection to flax-culture is, "that it requires so much farm help." This is true; but, as I have attempted to show in the introduction to this report, is a strong argument in favor of it, provided it can be shown that the large amount of labor required can be profitably and beneficially employed.

"It is especially desirable so to apply the productive power of the soil for the supply of articles as indispensable to the support of millions of our people as corn itself; and an additional inducement to the growth of flax, beyond that offered by other articles, may be found in the fact that, to bring it to the same condition as that in which it is usually imported from foreign countries, *calls for the employment of a considerable amount of human labor.**

It is evident to the careful observer, that unless there is a change in our agricultural system, the time is not far distant when we will have exported the essential mineral elements of the soil.† Whilst some other countries have steadily increased the average yield of cereals per acre, in this country there has been a steady decline. Already, in some of the Atlantic States, there are lands that will not pay for the cultivation. The area of profitable wheat culture is steadily moving westward. The introduction of such industrial crops as flax and hemp, and the sugar beet, would do much to bring about a needed reform. The manufacturers, stimulated by such productions, would tend to re-distribute population, and lessen the exportation of grain; and should we export the fibres, it would not be so detrimental to the soil as the exportation of grain and tobacco.

But I will not rely on the above economic reasons for the cultivation of these fibres, but will attempt to demonstrate that in these crops there is an immediate profit to the cultivator.

* Mr. R. G. Porter, Secretary Belfast Board of Trade.

† The total exports of wheat and flour within fifty years, previous to 1860, was equivalent to 1,062,000,000 bushels of wheat. Of this amount, but 178,000,000 was exported prior to 1850. In 1874, 91 000,000 bushels were exported.

Jas. Ward, who was an authority in Ireland on flax-culture, said: "Properly managed, there is perhaps no single crop that affords so ample a remuneration to the grower, or requires, looking to its results, a less amount of skill and attention; for, if the land be kept clean and well manured, as it ought to be for cereal crops of a healthy and vigorous growth, and if due care be taken with respect to rotation, a breadth of flax would yield to the cultivator a more profitable return than any grain that is ordinarily grown upon the soil."* The above statement of Mr. Ward has been verified by the experience of the best flax-growers of Ireland, where flax has been long known as the "rent-paying crop."

Mr. William Charley, a practical flax-grower in Ireland of large experience, gave his profits at £3 0s. 2*d.* per statute acre in 1853, after deducting all expenses, including rent and taxes, of £2 per acre. Mr. Charley said, "that, with ordinary care, a fair profit may always be expected, while *occasionally* a larger sum may be realized than by any farmers' crop grown in Europe.

The average profits in Ulster were estimated at from £4 to £5 per acre. The following were the profits per acre of

* Mr. Ward gives the following as a well-authenticated statement, to show not only what profits may be derived from good culture, but the large amount of extra employment it necessarily calls into practice at remunerative prices. Of course, this was by the old-fashioned hand processes, before the perfecting of machinery: 550 pounds of dressed flax, spun into 30 hanks to the pound, or 16,500 hanks, employed 158 females for twelve months, spinning at the rate of two hanks per week The wages for spinning each hank were 1*s.* 8*d.*, or nearly 7*d.* per day for each spinner. The yarn made 212 webs of cambric pocket-handkerchiefs, each web containing five dozen. To weave this quantity 18 weavers would be required, working twelve months, allowing each man a month for a web. The wages per web would amount to £2, or from 9*s.* 6*d.* to 10*s.* per man per week. About forty females would be employed for twelve months upon the same material, in needlework (hemstitch or veining), each female averaging one handkerchief per day, and receiving 8*s.* per dozen, or 8*d.* per day for wages. When finished, the goods would be worth £2 10*s.* per dozen.

By putting the estimate into another form, a clearer idea may be had of the amount of employment afforded by a comparatively small quantity of raw material, and the increased value it received from the application of skilled labor. The 550 pounds of flax called into active employment the following persons:

	£	*s.*	*d.*
158 Spinners, 12 months, @ 3*s.* 4*d* per week	1069	6	8
18 Weavers, 12 months, @ £24 per annum	420	0	0
40 Needle-women, 12 months, at 4*s.* per week	460	0	0
216 persons employed	£2195	6	8
Amount of wages	75	0	0
Cost of flax	£2270	6	8
Value of 1,050 dozen handkerchiefs, at £2 10*s.* per dozen	2625	0	0
Profit	£354	13	4

some of the leading flax-growers in that district for the years named:

	YEAR.	£	s.	d.
Mr. Charley	1853	3	0	2
Do.	1855	14	13	0
Do.	1861	10	13	0
Mr. W. Hunter	1852	5	6	7
Mr. Coales	1850	3	1	8
Mr. J. Hunter	1854	10	10	0
Mr. Birney	1852	9	10	0
Mr. Blakely	1850	15	10	0

The profits of flax-culture in this country ought to be as great as in Ireland,* on account of the cheapness of the land. It must be remembered that we import largely of foreign flax, and that the prices of good flax range as high or higher here than in Ireland.

The average yield per acre in Ireland was, in 1875, 460† pounds of fibre, and in 1876, 300 pounds. The Province of Munster gives the largest average yield, being 521 pounds

* Flax grown in 1855 on Mr. Charley's farm—1a., or., 2p., statute measure—over an average crop:

EXPENSES.

	£	s.	d.
One ploughing, heavy furrow	0	12	0
Seed, 2½ bushels	1	16	0
Harrowing, picking off stones, sowing seed, and rolling	0	10	0
Weeding	0	6	3
Cutting rushes and making ropes of same	0	7	0
Pulling and binding	0	16	5
Carting to yard and ripling under cover	0	18	4
Carting to water and fixing in same	0	7	6
Lifting out of water and drawing to grass	0	5	6
Spreading on grass	0	11	8
Lifting off grass and stooking	0	5	10
Carting to stack-yard, stacking, and thatching	0	8	1
Loading and drawing to scutch mill	0	4	6
Carting from mill and marketing expenses	0	6	3
Drying flax-bolls at corn-mill	0	3	3
Cartage, &c., of bolls	0	3	8
Rent and taxes, 1a., or., 2p.	2	5	0
Scutching 53 stone (742 lbs) flax, at 1s. 2d.	3	1	10
Total expenses	£13	9	1

RECEIPTS.

	£	s	d			
For flax fibre, 4 stone, at 10s. 3d.	2	1	0			
For ditto, 49 do., at 10s	24	10	0			
For scutching tow, 84 lbs	0	4	10			
For 60 bushels bolls for feeding	1	10	0			
				28	5	10
Profit				£14	16	9

Or 14£ 13s. 0d. per acre.

† This may be an under statement, as I have used the legal stone of 14 pounds. Flax is sold in Ireland by a stone (illegally so called) of 16¼ pounds. I think, however, that the legal stone is used in giving amount of yield.

per acre in 1875, and 498 pounds in 1876. On one farm, near Ballymena, the enormous yield of 1210 pounds per acre was reported, the money value of the crop amounting to £33 17s. per acre.* The grower of this crop attributed his success "to careful tillage and skillful handling." In 1852 the average yield (from official returns) in all Ireland was 580 pounds per acre; in Belgium, the average yield for ten years was 528 kilogrammes per hectare, which is equal to 470.2 pounds per acre. In France, in 1874, 80,607 hectares yielded 44,414,-457 kilos. of flax, being an average of 505 pounds per acre. The average yield in 1872 and 1873 was greater. In Holland the average yield was, in 1873, 496 pounds, and in 1875, 471 pounds per acre.

In Friesland it is stated that, in good seasons, the yield of flax reaches from 650 to 1,100 kilos. per hectare.† Here we have reliable data upon which to base calculations of yield on the fertile lands of Kentucky, bearing in mind that, in all of the above countries, great care is taken with this crop.

In Russia, where less care is taken with the crop, the average yield for 1877 was 280 pounds per acre.

I have collected a mass of evidence proving the profitableness of flax culture in this country; but such evidence is delusive, owing to the fact that the profits depend on the care bestowed upon the crop. I am certain that no crop will give a better return for careful treatment, and that in Kentucky flax can be made a profitable crop. With careful culture, the

* "The soil there (in the outlying counties of the Provinces of Munster and Connaught) might be called virginal, and he thought it might be expected to produce something like the large yields, which were referred to in the report, of £50 to £70 per acre in one year." * * "It might be said that if they put in flax they displaced other produce, *but there was no other crop that brought as much money* as flax. It would be a national advantage to have more tillage in Ireland, which had been too much of a grazing country. Grazing countries sustained very small populations."—*Speech of John Mulholland, Esq., M. P., Chairman of the Belfast Flax Supply Association, before the last Annual Meeting.*

† The following samples from Netherlands, now in the Geological Cabinet, will give an idea of the yield of flax, under good culture, in that country: 1. Crop of 1875 grown in the Province of Groningen; yield of fibre 760 kilos. per hectare; hand-scutched. 2. Province of Friesland; yield 784 kilos. per hectare; hand-scutched. 3 Province of Groningen; kin of Riga seed, 600 kilos. per hectare; mill-scutched. 4. Province of Friesland; yield 570 kilos. per hectare. 5. Province of Zealand; blue-blossom Dutch seed, yield 980 kilos. per hectare; hand-scutched. 6. North Holland, blue Dutch seed; yield 630 kilos. per hectare; mill-scutched. 7. Zealand, blue-blossom Dutch seed; yield 980 kilos. per hectare; hand-scutched. 8. White Zealand flax, reclaimed land; yield 560 kilos. per hectare. A hectare=2.4 acre; a kilogramme=2 2 pound.

Kentucky farmer can rely on obtaining from six to twelve bushels of seed, and from three hundred to four hundred pounds of fibre per acre. On page 101 the price of flax in New York City is given. Of course, the price will be regulated by the quality of the flax. The slovenly cultivator will get the minimum, and the painstaking cultivator the maximum prices.*

SOIL.—The first thing to be considered in flax-culture is the selection of soil. Flax grows on all kinds of soils and in all climates.† Fine flax is grown in Egypt, India, and Algeria,

* The following prices of flax from Belgium (samples of all in the Geological Cabinet, Frankfort) show how variable are the prices of flax grown in the same neighborhood. These are mostly from the crop of 1875. No. 12 is the finest sample of flax I can find any mention of. These prices are all "free on board": (1.) Ghent warps, £98 3*s*. 0*d*. (2.) Turnes flax, £90 0*s*. 0*d*. (3.) Walloon flax, £72 0*s*. 0*d*. (4.) Turnes flax, "for medium ways," £84 0*s*. 0*d*. (5.) Ghent flax, for medium warps, £93 1*s*. 8*d*. (6.) Ghent flax, superior warps, £106 10*s*. 2*d*. (7.) St. Nicholas flax, for warps, £115 19*s*. 0*d*. (8.) Malinese flax, for warps, £100 14*s*. 1*d*. (9.) St. Nicholas flax, superior warps, £128 13*s*. 2*d*. (10.) Courtrai flax, for thread, medium length, £119 2*s*. 1*d*. (11.) Courtrai flax, strong weft, long line, £215 2*s*. 1*d*. (12.) No. 1 superior Courtrai flax. £246 19*s*. 8*d*. The tow ranged from £32 2*s*. for scutched tow to £64 3*s*. 1*d*. for hackled tow from Courtrai flax. The following prices of flax, in the straw, deserve study, showing the value of the seed in Belgium, and at the same time what labor will add to the value of the raw fibre in the hands of the agriculturist: (1.) Belgium flax, in the straw, with seed on, crop of 1876, £18 0*s*. 2*d*. (2.) Belgium flax, in straw, without the seed, crop of 1876, £15 6*s*. 7*d*. (3.) Courtrai flax, in the straw, twice pounded in the river Lys. £50 2*s*. 6*d*.

† That the reader may have an opportunity of comparing the analyses of some of the best flax soils in Ireland with the various soils of Kentucky, as analyzed by the Chemist of the Geological Survey, I give the following analyses, by Sir R. Kane, of three excellent flax soils, No. 3 being probably the best, and one (No. 4) from Duffel, in Belgium:

	No. 1.	No. 2.	No. 3	No. 4.
Silica, &c.	73.72	60.41	64.93	92.78
Oxide of iron	5.51	5.29	5.64	.66
Alumina	6.65	5.70	8.97	1.11
Phosphate of iron	.06	.25	.31	.21
Carbonate of lime	1.09	.53	1.67	.35
Magnesia and alkalies	.32	.25	.45	.12
Organic matter	4.86	6.67	9.41	2.74
Water	7.57	11.48	8.73	2.03
Total	90.78	99.58	100.11	100.00

The organic matter in these soils was rich in nitrogen.

Analyses of celebrated flax soils from Russia, Belgium, Holland, and Ireland:

	RUSSIA.	BELGIUM.	HOLLAND.	IRELAND.	IRELAND.
	Average of two samples.	Average of two samples	One sample	Average of two samples, Derry and Armagh.	Slob land of Lough Foyle.
Silica	82.21	83.93	60.94	69.32	79.36
Lime	.45	.35	.36	2.36	1.19
Alumina	6.93	1.29	5.66	7.81	3.31
Iron	Trace	Trace.	6.04	.45	7.49

and in Northern Russia, Norway, and Sweden; and whilst some countries reasonably claim a peculiar adaptability for growing superior flax, on account of climate and other favorable conditions, I am of the opinion that the finest fibre is usually produced by the people who bestow the most intelligent care in the cultivation of the plant and after-treatment of the fibre. Sandy loams and well-drained alluvial soils seem to be better for the production of the finest crops.

The finest flax is grown in Belgium. Of the soil, the "English Agricultural Gazette" says: "It is not to the fertility of the soil that the fine crops of flax in Flanders are to be attributed, as a very brief inspection of it will suffice to show. We have before us a sample of soil taken from a celebrated district, at which we do not hesitate to say many an English farmer would turn up his nose as beneath his notice and unworthy of his cultural cares. It is to the careful working of the soil, the unstinted supply of manure, of which the quality and mode of action on the soil and plants is a matter of careful and anxious study; to an equally careful attention to the quality of the seed and the properties of the plant; and last, but not least, by carrying out a well-considered system of rotation, that the Flemish farmer owes his success in flax-culture."

In Courtrai the soil is a clayey sand or loam. This soil was originally quite poor and unproductive, but has been made fertile by years of painstaking tillage. (See page 9, Introduction.) Northern and Eastern exposures are preferred. Warm, shady places are thought to produce long fibres, but weak. The following from a practical flax-grower of Auburn, New York,* gives the character of soil preferred in that State: "Flax will flourish well on any soil that will yield good crops of cereal grain; and some soils that do not produce abundant crops of certain kinds of grain will produce an excellent crop of flax. Flax likes a deep, fertile, and mellow loam, and on such soil a heavy crop of both seed and lint may be produced, provided there be not an excess of water in the soil. Those river bottoms and uplands where the predominating charac-

* "Prize Essays," Orange Judd & Co., New York.

teristic of the soil is black muck, if fertile enough to produce heavy grass, will yield a good crop of flax fibre and a small crop of seed. But if the soil is in a good state of fertility for yielding potatoes, oats, Indian corn, or rye, the yield of both seed and fibre will be large. *Flax will not flourish on wet soils of any kind*, and the crop will be light on heavy, slippery clay soils, unless thoroughly underdrained, well pulverized, and enriched with fertilizing materials. A good crop of flax cannot be produced on a poor, wet, and half pulverized soil, any more than can a good crop of wheat." An Irish authority says: "As we approach a heavy retentive clay, or very light sand, our chances of success become less."

THE PREPARATION OF THE GROUND will depend much on the character of the soil. A deep, fine tilth is essential. A Belgian flax-grower, employed by the Royal Flax Society of Ireland to give instruction, says: "A light ploughing immediately after harvest is required for all soils; but if they be heavy and stiff, they should be laid in ridges before winter, and thus to remain until a fortnight before sowing, when they should be deeply ploughed. Light soils may have their last ploughing before the setting in of winter. If the land be not sufficiently rich, liquid manure or rape-cake powder should be applied before sowing the seed, after which it should be harrowed and rolled, and should look like a garden." The soil should allow the roots to penetrate to one half the length of the stem above ground. It is essential to keep the land free from weeds; and for this purpose, an early spring ploughing would be well, to allow the weeds to sprout, so that they could be killed by the subsequent harrowings. Hemp would be an excellent preparation for flax, freeing the land from weeds; and, if the hemp was retted upon the land, and the shives burned, or better, spread over it in the spring, the land would be in good condition. In Belgium, the preceding crops, for several years, are regulated with reference to the flax. On good soils, flax follows well after clover, tobacco, hemp, or wheat. On light soils, the crops preceding flax are generally barley or rye, with turnips after them the same year. These preceding crops are manured with especial reference to the flax. Strong soils, and those that are coarse and wet, are usually cross-ploughed before winter. If the flax follows clover, the land which has been manured with farm-yard manure or peat ashes, receives in the autumn a like quantity of the same manure, which is covered with the plough, and well harrowed to make the soil lively. In the spring a vigorous harrowing is given and the seed sown. When flax follows hemp which has been well manured, the soil receives a working before winter, the land resting until the month following, when it is ploughed in high ridges and manured with liquid manure or ashes. It is when flax follows hemp, on land well manured, that the best crop may be relied upon.

As we have not yet in Kentucky adopted the use of manures on our hemp-land, I would advise the farmer contemplating the growing of hemp and flax to study Dr. Peter's excellent work on Hemp and Buckwheat Plant, particularly that portion relating to the supply of the necessary amount of humus, by ploughing under such green crops as rye or buckwheat. By ploughing the hemp-land in the autumn and sowing rye, which could be pastured during the winter, and ploughed under early in the spring, the soil would be left in good condition for the flax. Some cultivators advise shallow ploughing in the spring (provided the land has been ploughed deep the preceding autumn), so as to preserve the winter surface for the roots of the young plant. The object to be attained is the production of a *fine, deep, dry, and clean bed* for the reception of the flaxseed. Any good farmer will know the best means of obtaining these.

MANURES.—The use of green stable manure is to be avoided on account of the ungerminated seeds contained in it. It is asserted that, in newly-cleared lands, the ashes from the burned wood and brush is highly beneficial to flax. The Belgians prefer liquid manure, collected mainly from the cow-house, stable, &c., and allowed to ferment in cisterns built for the purpose; with this oil-cake is mixed. The quantity of this manure varies from 100 to 300 hectolitres per hectare. As many as a thousand oil-cakes are sometimes applied to an acre. Solid manure is only used after being thoroughly composted and rotted. Prof. Hodges, of Ireland, after a careful analysis of the flax-plant, concluded that all of the inorganic matter removed from the soil by two tons of flax straw might be replaced by the following compound:

Muriate of potash	30 pounds, cost now about	$1 80
Chloride of sodium (common salt)	25 pounds, cost now about	05
Burned gypsum	34 pounds, cost now about	30
Bonedust	54 pounds, cost now about	1 00
Sulphate of magnesia (Epsom salts) . . .	50 pounds, cost now about	1 25

Should the flax be retted on the ground, and this compound added, a constant increase in fertility would be the result. The value of the shive as a manure is shown by the following experiment taken from the proceedings of the Flax Society:

In 1847, a rood of flax, Irish measure (which had been in oats in 1845, followed by flax in '46), was divided in four equal parts for the purpose of trying the different application of manures. To No. 1 was applied 28 pounds of manure recommended by Liebig for flax; to No. 2, 28 pounds of guano, mixed with an equal weight of powdered gypsum; to No. 3, a quantity of shives, or woody part of the dried stems of flax, calculated as equivalent to the weight of an average produce on the same breadth of land; to No. 4, a quantity of the water in which the produce of the same estimated weight had been steeped. These manures were minutely incorporated with the soil. On this Riga seed was sown. The crop grew well, and produced a fair return, as will be seen by the following table:

No.	Substance applied.	Product of fibre.	Price per stone.	Value of fibre.	Produce by Irish acre.	
					Stones of fibre.	Value.
		Pounds.	£ s. d.	£ s. d.		£ s. d.
1 . .	Liebig's manure.	61	8 9	4 13 3	61	26 12 0
2 . .	Guano and gypsum.	55	9 3	1 11 10	55	24 13 4
3 . .	Shives.	55	10 3	1 15 3	51	28 4 0
4 . .	Steep-water.	55	9 6	1 12 7	51	26 1 4

Chemical fertilizers have the advantage of being free from seed of noxious plants, and no doubt can be used on flax to advantage. The agriculturist should proceed with extreme caution in the use of this class of manures. The wise farmer will, as far as practicable, produce upon his own land the manures necessary to keep up its fertility.

SEED.—Great care should be exercised in the selection of seed, as the success of the crop depends largely upon the quality. American seed was formerly highly esteemed in Ireland, but the Dutch seed is thought to produce a larger yield, and to ripen sooner. As with other crops, an interchange of seed is thought to be highly beneficial. Seed is thought to be of good quality when it is bulky and heavy, the faces of each seed being equally swollen and convex; the color should be uniform, and the skin smooth and brilliant; it should sink easily in water, and when burnt, it should consume with clearness and rapidity. Seed older than two years should not be used. In some districts in Belgium, the seed of the second year is sown, as giving the best produce. To test the seed, to see if it has lost its germinating powers, place a few seed upon a damp, outstretched flannel. If the seeds thus placed germinate equally, and in the space of about twenty-four hours, it may be reckoned upon as good; if the germination is delayed for several days, and takes place unequally, the seed will not be desirable. Care should be taken to clear it of the seeds of weeds, which are often mixed with it, and if not removed, will cause subsequent labor when the crop is growing.

This separation is generally effected by fanners and a wire screen, which has twelve bars to the inch. Supposing that our farmers procure seed from abroad every four years, they should be careful in saving each year enough seed for planting; this will insure them against loss, should the imported seed fail to germinate. The thin portions of the growing flax might be reserved and allowed to ripen for seed. In Flanders, they make a distinction between plants which bear a close and those which produce an open or gaping capsule or seed vessel, the latter being preferred. The Dutch Association for promoting the interests of flax industry recommend the White Blossom Dutch seed as favorable for America; producing an abundance of seed, and, at the same time, a sufficient, though coarser fibre, that has a great value, especially for manufacturers in America. The Blue Blossom Dutch will be preferable where a fine fibre is desired. Seed from the Netherlands can be obtained through the above named Association.*

From the Northwestern States, where the crop is grown only for the seed, and allowed to ripen well, good seed can be obtained.

In the spring of 1846, experiments were tried near Belfast to test the comparative produce of flax grown from different kinds of seed.† The soil was a light, sandy loam. The previous crop had been green. Five square roods (Irish measure) were sown with American, Riga, Dutch, Irish, and one-year old Riga seed. Each was the best quality of its kind. The old Riga was of the importation of 1845. Each plat was sown at the rate of 3½ bushels per Irish acre (Irish acre equals 7,840 square yards). The season was peculiarly unfavorable, and the growth everywhere scanty and bad. The following tables are only valuable as exhibiting the comparative produce of the several kinds on the same soil, and managed similarly. The flax from twenty square perches of each plat was steeped when pulled; the produce of the other twenty being dried on the Courtrai method, and steeped in the spring of 1847. The latter division was the poorest crop on the ground:

* Persons desiring to import foreign seed for planting, can order through their commission merchants, or they can get pure Russian seed by ordering from the following: Odessa Exchange Committee, Odessa; Bessarabian Horticultural School, Kishinef; Committee of Riga Exchange, Riga.' The Dutch seed can be obtained from the Dutch Association for Promoting Flax Industry, Rotterdam, or from Cruigs Van Casteel and Knight, Rotterdam.

† Proceedings of Flax Society. 1848.

GREEN STEEPED LOT, TWENTY SQUARE PERCHES, IRISH, TO EACH.

SEED.	Weight before steeping, without bolls.			Weight after steeping and drying.			Clean fibre	Produce of clean seed.	Produce of flax per acre.	Produce of seed per acre.
	cwt.	qrs.	lbs.	cwt.	qrs	lbs	lbs.	quarts.	pounds.	bushels.
American	12	3	7	4	2	0	42	46	336	11½
New Riga	12	2	23	4	1	0	54	40	432	10
Dutch	12	1	1	4	1	4	49	44	391	11
Irish	13	2	14	4	0	0	70	42	540	10½
Old Ridge	10	3	24	3	1	0	45	40	360	10

COURTRAIED LOT, TWENTY SQUARE PERCHES, IRISH, TO EACH.

SEED.	Weight when pulled with seed-bolls.			Weight when dried ready for stacking.			Clean flax	Produce of seed fit for sowing.	Produce of flax per acre.	Produce of seed per acre.	
	cwt.	qrs.	lbs.	cwt.	qrs.	lbs.	lbs.	quarts.	lbs.	bu.	qts.
American	13	1	2	5	3	11	28	28	228	6	22
New Riga	13	0	11	7	0	2	33	52	264	13	0
Dutch	13	0	24	6	0	21	32	32	256	8	6
Irish	12	1	25	5	1	9	37	32	296	8	0
Old Riga	11	1	8	4	3	7	32	28	256	7	0

SOWING THE SEED.—It is of prime importance that the seed be sown evenly. The quantity will depend on the object for which it is grown. If only for the seed, it should be sown thin, so that the plants will grow branching, many of the branches being as large as the main stem; on all of which will form seed-bolls. I would not recommend thin sowing, for it is possible to grow the flax both for the fibre and seed at the same time. If grown for the seed only, from three pecks to five pecks of seed should be sown to the acre. In Ireland, from two and one fourth to two and one half bushels per acre are sown; in Belgium, often as much as three and a half bushels per acre. I would not advise the sowing of less than two bushels per acre, where a good fibre and profitable yield are desired. Sow as early as the condition of the ground and weather will permit. Finer fibre is obtained from early sown flax. Good results, however, can be obtained by sowing, whenever conditions are right, from March to latter part of May. Never sow during rain, or when the soil is wet. To insure even sowing, stake off the land, and mark from stake to stake by drawing a chain across the land, after it has been harrowed and rolled. Make the lines about twelve feet apart. Having ascertained the quantity of seed necessary, divide the total quantity in quarts by the number of beds, so as to ascertain the number of quarts requisite for each bed of twelve feet. The sower should proceed with a regular step, taking small, tight handfuls, and casting the seed, with regular throws, high and fearlessly, letting each cast slightly overlap the preceding one. Care must be taken that the seed, which is very slippery, does not escape in the backward swing of the hand. Some cultivators advise soaking the seed in slightly warm water for two or three hours, and then rolling it in plaster or gypsum. This renders it less slippery, and the gypsum is beneficial to the germinating plants.

The seed should not be covered deeper than one inch, and it is important that they be covered as nearly uniform as possible. It is unadvisable to allow a team of any kind to pass over the land after the seed has been put in. A brush harrow, drawn by hand, is the preferable way of covering the seed. Such a harrow can be made by inserting the butt ends of brush about two feet long into holes bored into a three by four scantling, which should be about five feet long. To this scantling attach shafts or handles, so that the harrow can be drawn by a man or boy. By this means several acres can be "brushed" in in a day. It would be well to cross-harrow the land with this brush, so that no ridges be left, and the land left uniformly smooth.

Weeding.—After the flax has been carefully put in, it is important that it be kept free from weeds. If the land has been carefully prepared, and freed from weeds by the preceding crops, little trouble will be experienced, if the flaxseed sown be free from noxious seeds.* The weeding, if necessary, should be performed when the flax-plants are about five or six inches high. In Belgium, the weeding is usually performed by women and children, with coarse cloths round their knees, or better, a mat which is spread over the flax, and moved forward as the weeding progresses. The weeders should move across the flax-patch in one direction in a straight line, against the wind, so that the plants laid flat by the pressure may be blown to an upright position after the passage of the weeders. The men put on woolen socks or go barefooted. The plants should not be twisted or tangled.

PULLING.—It is of great importance that the flax be pulled at the proper time. When the lower part of the stems begin to assume a yellow color, and the seed capsules are formed, and the seed begins to change from a green color to a pale brown, it is the proper time for harvesting the crop. If the flax be left standing until the seed is fully matured, the fibre will not be so good. The seed will ripen sufficiently if not detached from the plant until dry, as the sap contained in the plant contributes to the further perfecting of the seed. The seed will not be so heavy as if allowed to ripen before the pulling of the plant. It is claimed, however, that by the "Courtrai system" of keeping the flax one year in the stack before retting, the fibre is improved, and a superior quality of seed is obtained. This system will be referred to under the head of Retting.

When the flax is standing erect, a handful should be grasped with both hands, just below the seed-bolls, and pulled ob-

---

"Common among the weeds found with flax are the small and great 'bindweed,' respectively *convolvulus arvensis* and *C. sepium*. It is of a twining habit, the roots penetrating deeply and spreading rapidly, and maintaining their vitality under severest persecution. *Cuscuta Europea*—Dodder, 'devil's-gut.' *C. epilinum*—Flax-dodder, found in nearly all foreign flaxseed. It is a small, yellow, leafless vine, sometimes known as 'gold-thread vine,' twining around weeds in damp places, in tangled masses like bunches of threads of yarn. Its effect is very deleterious upon flax, stunting the stem and impairing the fibre.

"*Camilina sativa*—'false flax,' 'gold of pleasure'—the large yellow seeds found in flax with some resemblance to flaxseed. *Sinapis arvensis*—Charlock, wild mustard—is found in a loamy soil, such as flax delights in. Sheep eat it with relish when turned out in the spring."

liquely from the ground with a sudden jerk, the dirt adhering to the roots shaken off, or knocked off against the boot. The handful or "beets" should be kept even at the root-ends, of an even size, and laid straight upon the ground, two handfuls together, crossing each other diagonally. (These operations are well shown in figure 1, page 23.)

If there is much second growth or short flax, it should be pulled after the long flax, and put in separate bundles. If the seed be ripe, it should be rippled at once, before putting the flax into sheaves; but if it has been pulled as advised, before the ripening of the seed, the "beets" should be made into small bundles or sheaves,* tied loose, so as to admit circulation of air through the bundle. The bundles should be set up in long stooks, twelve or more in a stook, the root-ends resting on the ground, and the seed-ends resting against each other; the stooks placed in a north and south position in the field, so that the sun may shine on both sides during the course of the day. Several days will be required for the drying of the flax and maturing of the seed, the time depending upon the nature of the weather and the condition of the crop when pulled. If the crop has been heavy and lodged, some extra time will be necessary. Flax is sometimes cut with a scythe or with a reaping-machine. This is not a proper method, except when it is alone desirable to gather the seed. Several machines have been invented for pulling flax; but the information received of the working of them is such that I cannot recommend them. They may hereafter be perfected so as to do the work in a satisfactory and economical manner.

Stacking.—If a clean barn or building is to be had, it is preferable to put the flax under shelter until the time for rippling and retting; but it can be put in stacks, so that little or no damage will be done by the weather. If the farmer intends to water-ret the flax, I believe stacking to be an unnecessary expense, as the flax can be rippled from the stook and

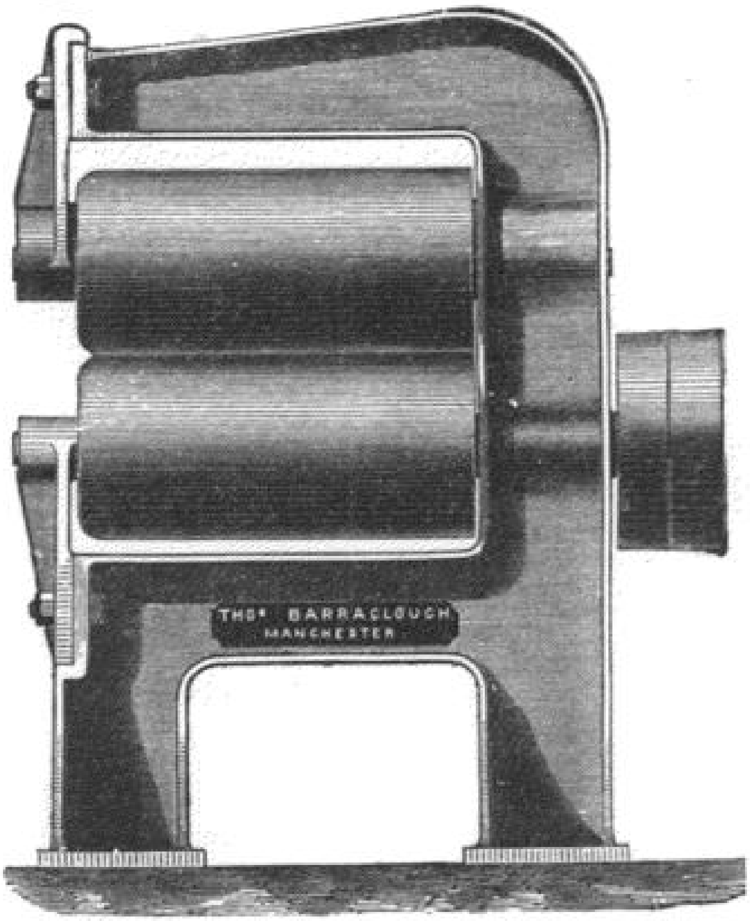
* The bundles should be tied with sun-dried rushes, twisted wisps of hay, or something similar—not with the flax straw.

taken at once to the retting-pool. Where stacking is necessary, a good foundation should be made by placing logs alongside for the width of the stack, or building a foundation of fence rails high enough to prevent dampness on the bottom of the stack. On this foundation, the width of which will be determined by the length of the flax, lay two courses of sheaves, the seed-ends together, and continue one course above another until the required height is reached. Build the top so as to give a slant, and cover with boards, projecting the eaves enough to keep dry the outer ends of the flax. It is possible to make a good thatch of the flax straw; but the fibre of straw so used will be damaged, and it is preferable to use boards or a covering of straw.

RIPPLING.—Unless it is desired to save the seed for planting, the rippling should be carried on at the same time and in the same field with the pulling, as this saves extra handling; and if the flax has been pulled at the proper time, the seed will be sufficiently matured for feeding purposes, or for oil.

The best ripples are made of half-inch square rods of iron, placed with the angles towards each other, three sixteenths of an inch apart at the bottom, half an inch at the top, and eighteen inches long, to allow a sufficient spring, and save much breaking of flax. The points should begin to taper three inches from the top. These rods are to be fixed firmly in a block of hard wood, forming a comb of about eighteen inches long. This comb is to be screwed on to the centre of a plank about nine feet long, resting on two stools, or legs placed in the ends. The ripplers may stand or sit astride at opposite ends, at such a distance from the comb as to permit their striking it properly and alternately. A winnowing sheet should be placed under them to receive the bolls as they are rippled off. The above can be moved about the field, so that the straw need be carried but a short distance. The rippler takes up a handful, holding it about six inches from the root-end with one hand, and just below the seed-bolls with the other. He then spreads the top of the handful like a fan, and draws one half of it through the comb, the other passing by the side; with a half turn of the wrist the same operation is performed with the remainder. The methods of pulling through the comb must, however, depend on the quantity of the bolls. The straw, when stripped of its bolls, is carefully laid down, each handful diagonally, after which it is tied up into sheaves ready for removal. The object of crossing the handfuls, after rippling, is, that they may separate easily when taken out to spread on the grass for retting, or for drying after they have been water-retted.*

If the weather be dry, the bolls should be kept in the field, spread on the winnow-cloths, and occasionally turned. If the weather be wet, the bolls should be taken indoors and spread out evenly and thinly on a clean floor, and turned twice a day, leaving open windows and doors to allow the passage of air. When dried, the seed should be threshed out. The chaff and light seed removed by the threshing is considered excellent food for cattle. The process of grinding the seed and extracting the oil will be described elsewhere. Another plan of rippling, which has some advantages, is to pass the seed-ends of the straw through plain revolving rollers, which crush the capsules, so that the seed can be separated from the chaff by winnowing. One end of the rollers should be free, so that the operator can stand at the end and pass only the ends of the straw through.



The accompanying is an illustration of a machine, most generally used in Great Brit-

* The ancient Egyptian method of rippling is well shown (*e, figure* 1) on page 23.

ain. It consists of a strong cast-iron frame, in which two heavy, cast-iron rollers revolve. The bottom roll is driven by means of the pullies, as shown in the figure. The top roll revolves by contact with the bottom one, and is free to rise and fall in its bearings, the pressure applied in the rippling process being thus due to the weight of the top roll. Both the rolls are made slightly conical at the end near the opening of the frame. This is for the purpose of facilitating the introduction of the seed-ends of the flax-straw between them. After cleaning and drying, the seed should be stored; but great care should be taken that the seed is perfectly dry before it is stored, or it may damage by heating.

STEEPING OR RETTING.—This process requires so much care and skill to prevent the injuring of the fibres, that it constitutes a chief drawback to the cultivation of flax. Many experiments have been tried to separate the fibre from the boon or woody portion of the stem, without the tedious and costly process of retting; but these experiments have only been partially successful, and, from the nature of the plant, it is probable that this process cannot be dispensed with.

The stem of the flax-plant consists of a central woody part, called *shive* or *boon*,* surrounded by a tough fibre, called *bast* or *harl*, which, with its fine cuticle, incloses the boon like a tube. The harl furnishes the flax-fibres, and these are, in their natural condition, cemented not only to the boon, but to each other, by gummy compounds of great adhesive power. To destroy this union is the aim of all retting processes. If it be done mechanically, it must be at a great waste of fibre; and after the fibre has been manufactured, the dampness will cause decomposition of this "gluten," and result in the injury of the manufactured article. It is, therefore, necessary to rid the fibre of this cementing substance, and this is best done by the various methods of retting, divided simply into

* The names given to the woody portion of the stem are so numerous as to cause confusion. Most of the early writers on flax used *shove;* but this is seldom used now, and is not found in Webster, although it has the weight of such writers as Royle, Charley, Ward, Warden, Ryan, &c. The following are used indiscriminately: *shive, shove, boon, hurd, reed.*

"*water-retting*," or immersing the flax-straw into still or running water until fermentation has deprived it of the gluten; or by "*dew-retting*," exposing it to the influence of the sun, air, and moisture. The water-retting is divided by the many processes, using artificial heat, chemical aids, &c., which will be treated of hereafter.

Nearly all of the flax hitherto grown in this country has been dew-retted. This is also practiced in the Archangel districts of Russia and in portions of Germany. Although the fibre is not so strong and bright as when water-retted, a fine, soft fibre may be obtained in this way, and it requires a shorter time for bleaching, and has the advantage of simplicity; and by this means the fertilizing properties contained in the flax are washed into the soil. About the first of October the flax is spread in straight rows or swaths on a smooth meadow, free from weeds and long grass. There should be a space of several inches between the swaths to prevent tangling. The flax should be spread thinly, and evenly at the butt-ends. After it has been down for a week or ten days, it should be turned upside down, by running a long, straight pole beneath the swath, near the top ends of the straw. A person at either end of the pole can lift it, and turn the flax without tangling. From two to four weeks will be required to effect the retting, the time depending upon the weather. The flax should be examined at least once a day, after it has been down for what may be considered a sufficient time, to see whether it is ready for lifting. Try some stalks by breaking in several places, six or eight inches apart, and if the woody part snaps brittle, and will pull freely out without tearing or breaking the fibre, with none of the fibre adhering to it, the flax is ready to be taken up. In lifting, keep the lengths straight and the ends even; set it up to dry for a few hours, and afterwards tie in small bundles; and if not taken to be scutched, it will be improved by being put in small stacks, loosely built, on a foundation high enough to allow free circulation of air under the stacks.

The finest fibre is obtained by water-retting and grassing combined. I have been at pains to collect the various methods practiced in flax-growing countries, and I will give them, as they may each of them give valuable hints to the flax-grower.

The river Lys, which rises in the north of France, flows northward into Belgium, past Courtrai, and empties into the Scheldt at Ghent, is supposed to possess peculiar properties for the fermentation of flax, such as is possessed by no other water; and it is believed that flax steeped in this river yields a fibre superior to any other. Flax produced in other districts is often hauled from thirty to forty miles and steeped in the Lys; and as Courtrai is the chief seat of this industry, all flax so retted is termed Courtrai flax. By the Courtrai method flax is considered in the best condition when dry, and at least a year old.

The flax, tied up in small bundles, is placed perpendicularly in wooden frames or crates of from twelve to fifteen feet square. Each crate is launched into the river, and straw and clean stones laid upon it until it sinks just enough below the surface of the stream to leave a current both above and below it, which carries away all impurities, and keeps the fibre clean during the period of immersion. The average time required is from seven to ten days. Towards the end of May, the average is nine to ten days; in August, seven days; in October, twelve. As soon as the flax has been sufficiently steeped, the crates are hauled on shore, and the flax spread upon the grass to dry, preparatory to undergoing the process of breaking and scutching. The "*rouissage*" at Courtrai is usually performed in May, or in August and September, after which the flax-merchants of Brabant and the North send their agents among the farmers, who purchase from house to house; and on a certain day attend at the chief town to receive the "deliveries," when the qualities of the crop and the average prices are ascertained and promulgated for the guidance of the trade.*

In the Paes de Waes the flax is steeped green, or immediately after rippling. The water used is allowed to become partially stagnant before the flax is put in. The pools are

* Tennent's "Belgium;" Burns' "Agricultural Tour."

very clean, and often a basket or wicker-work is used on the bottom to prevent the flax from becoming soiled. These pools are often so arranged that the water can be drawn off, and renewed at will; and flax retted in this way is considered to have more weight than when retted in running water. By both of the above methods fibre of superior fineness is obtained.†

In the Netherlands flax is generally steeped in pools prepared for the purpose. Stagnant water is preferred there to running water, as the flax steeped in this way is supposed to be heavier; but it has been suggested that perhaps the extra weight may be gluten, which the running water would have washed away. The pools are sometimes lined with blue clay, which is thought to give a rich blue color to the flax. The flax is taken from the pools, placed in stooks to drain, and thinly spread upon the grass, and turned frequently to expose the fibres to the sun.

In Ireland, great care is bestowed upon the watering of flax. The following, condensed from the report of the Committee of the Royal Flax Society, and revised by the Special Committee of the Northeastern Agricultural Association of Ireland for Promoting the Growth of Flax, will give the most approved method in practice there: River-water is the best. If spring-water has to be used, let the pond be filled some

† The fineness of the fibres treated by the above methods may be appreciated by the following notes on the flax exhibited from Belgium at the Dublin Exhibition: "The specimens of flax were examined by the best attention we could command, aided by perhaps the best practical experience in Ireland; and we never saw anything to equal them for fineness, softness, and lustre, combined with neatness of handling. The series examined included three samples from Lokern, in the Paes de Waes, all of beautiful quality; some white and blue Burges, and three fine specimens from Courtrai. Few of these qualities were worth less than £70 per ton, and some of them ran as high as £150, whilst the finest was estimated at £200 per ton; but even this high price is considerably outdone by the fibre from which the Mecklin and Brussels lace is made, as it has been known to sell for £4 per pound when heckled, or nearly £9000 per ton! Yet, in this extreme case, so little does the value of the material enter into that of the exquisitely fine product, that a lace handkerchief, weighing about two ounces, has been known to sell for 2500 francs, or £100." "There were, however, two kinds of flax exhibited—one marked 'Flemish' (Paes de Waes), and the other 'Courtrai' These were *equally* fine, but differed much in color, the former being of a slaty-grey, and the latter of a yellowish-white. This difference arises, we apprehend, from the two modes of treating the flax. The former is retted when the stems are green, and after the seed-capsules have been removed by rippling; the other is the result of treatment by the Courtrai method—stacking after harvest, rippling during winter, and steeping in the river Lys the following spring or summer."

weeks, or months, if possible, before the flax is put in, that the sun and air may soften the water. That containing iron or other mineral substances should not be used. If river-water can be had, it need not be let into the pond sooner than the day before the flax is to be steeped. The best size of a steep-pool is twelve to eighteen feet broad, and three and a half to four feet deep. Place the flax loosely on the root-ends in the pool, in one layer, somewhat sloped, and in regular rows, the tie of each row of sheaves to reach the root of the previous one; cover with moss sods, or tough old lea sods, cut thin, laid perfectly close, the sheer of each fitting the other. Before putting on the sods, a layer of rushes or ragweed is recommended to be placed on the flax, especially in new ponds. As sods are not always to be had, a light covering of straw may do, with stones laid on it, so as to keep the flax just under the water; and as the fermentation proceeds, additional weight should be laid on—to be removed as soon as the fermentation ceases—so as not to sink the flax too much in the pool. Thus covered, it never sinks to the bottom, nor is affected by air or light. A small stream of water allowed to run through a pool has been found to improve the color of the fibre. If the pools are in a line, the stream should be conducted along the one side, and run into each pool separately, and the water of each pool run off, along the opposite side, in a similar manner. It will be sufficiently steeped, in an average time, from seven to fourteen days, according to the heat of the weather and the nature of the water. Every grower should learn to know when the flax has had enough of the water, as a few hours too much may injure it. It is, however, much more frequently *under*-watered than *over*-watered. Never lift the flax roughly from the pool with forks, but have it carefully handed out by men standing in the water. It is advantageous to let the flax drain twelve to twenty-four hours after being taken out of the pool, on the root-ends, close together; but the heaps should not be too large, otherwise the flax will be injured by heating.

The steep-water can be used either as a liquid manure for meadows, or kept in the pool until the first flood. It should not be run off into the stream when the water is very low, as the odor is unpleasant, and the water so impregnated may be poisonous to the fish.

The foregoing are the most approved methods of retting flax. The intelligent cultivator will study them all, and see which is most suitable to his requirements. An important congress of flax-consumers and producers, held in November of 1873, in Vienna, passed, among others, the following resolution:

"That the water process of steeping, as carried on near Courtrai, in the Lys, yields the best results."

I would advise the flax-grower in Kentucky to begin with dew-retting, to be followed by water-retting, after he has gained experience in the management of the crop. The third process of retting embraces hastening the putrefaction or combustion by artificially raising the temperature of the water, or by treating with steam. As there seems to be grounds for a feasible improvement in this direction, I will give the several processes, in hopes that hints may be gathered by the practical flax and hemp-growers, and that the experiments begun by Schenk, Watt, Pownell, and others, may be carried to greater perfection.

SCHENK'S PROCESS is probably the most successful of practical improvements. It was patented in 1846 by Schenk, a native of New York, and was by him introduced into Ireland. The idea was probably not original with him, as it is similar to a process patented by Milton Barlow, of Kentucky, in 1839, for the treatment of hemp.* It was very similar to a process proposed by a Mr. O'Reilly, described in a pamphlet by Dr. Stephenson, of Belfast, in 1808. The employment of warm water, instead of the ordinary atmospheric temperature, was proposed as early as 1787 (Ryan).

*The Barlow process for steam-retting hemp will be described hereafter, under the head of "Hemp."

However, to Schenk belongs the credit of first introducing into practical use, and erecting works for the treatment of flax by the process which now bears his name. The principle of Schenk's plan is plain and simple. It consists in substituting for the irregular out-door watering pools, the certain and regular effect of water heated to a given temperature under cover, so as to hasten the fermentation necessary to effect the separation of the clean fibre from the stem. The water was heated to a temperature of from 80° to 90° Fahrenheit, and the time required did not exceed sixty hours. The following description is condensed from the report of the Secretary to the Committee of the Flax Society, 1848:

The Committee will remember, that on the first communication by the patentee of this process, about eighteen months ago, partial trials of its efficiency were made, on a small scale, in Belfast, the Secretary and Mr. Haslett, one of the Society's agriculturists, having superintended the operations. The result satisfactorily established the truth of the patentee's declaration, that flax could be as thoroughly retted in sixty hours, by steeping in vats, in which the water was maintained at a temperature of 90° Fahrenheit, as it is generally, on the usual system, in from seven to twenty-one days. Subsequent comparative trials of the two modes, by a man in Monaghan county, confirmed this fact, and established the further important point, that the yield of fibre from the straw is greater by the patent process than by the ordinary method, the amount of flax from 112 pounds of straw being, by the former, 20 pounds; by the latter, 24 pounds—a difference of 20 per cent. in favor of the American (Schenk) system. From experiments made by Messrs. W. Renshaw & Co., Manchester, it still further appeared, that of these two samples, the former spun to 101 lea yarn, and the latter to 96 lea. * * * * *

The reducing to a certainty an operation hitherto attended with risk, is owing to the changes of temperature in the air and water, and the comparative skill of farmers, and attention of their laborers. It is well known to every one who has managed flax, that one sultry night, while it is in the steep and nearly retted sufficiently, is enough to carry the fermentation beyond the safe point, and to weaken the fibre, so as to cause after-loss in the scutching. So much is this feared by farmers, that almost all flax is under-watered; and although much of it is afterwards *mannered* on the grass, so as to obviate this fault, yet much is brought to market with the shives still unseparated, in bits, on the fibres. The uniform temperature of the water, as heated by steam, insures the uniform retting of the flax, while the hands become skillful in knowing the exact point at which the process should be arrested.

A uniformity of quality and neatness of handling is much more likely to be obtained from a set of persons constantly engaged in working with flax throughout the year, than from farm laborers taking up the steeping and grassing of flax once in every twelve months, and reducing a critical and semi-chemical operation to a mere item in the usual work of the farm.

Flax would be much more generally grown if a market could be offered for it as pulled, farmers often objecting to the trouble and risk entailed in the subsequent manipulations. The same objection does not exist in the case of the Schenk system, since the flax, when dried in the field and stacked, can be kept in that state, without any deterioration of quality, until it be convenient to steep it.

Where steam exists as a motive-power for any kind of machinery, vats can be erected at small cost, and the spare steam used to heat them, without the expense of a special boiler and apparatus.* Hence the easy applicability of this system in almost all parts of the country, and its especial adaptation when a scutch-mill is driven by steam, the fuel being the shives produced in the scutching operation. The mill would thus work up the flax steeped in the vats, and the steam generated by the shive-fuel would equally drive the engine to scutch the fibre, and heat the water to rot the stems.

* The numerous engines and boilers used in threshing grain are idle most of the year, and many of them might be employed profitably in this way, as a breaking and scutch-mill should be attached to the rettery.

"These are the chief points on which I would found an estimate of the advantages likely to be derived from the general adoption of this system of steeping. There are other points of considerable interest, such as economy of the steep-water for the purpose of manure, and the employment of a number of hands throughout the year, where the management of flax has only formed an item of the usual field-labor of the agricultural population; the training of these in a semi-manufacturing occupation, including habits of system and industry, in remote districts, where the desultory character of farm-work has not this desirable effect, the uniformity and superiority of handling which must raise the character of Irish flax, and induce its consumption by the Continental spinners.

"It may appear to the Committee that I have taken a rather sanguine view of the merits of this system; but I simply speak from conviction, induced by personal observation, which conviction only came after I had rejected, as a matter of caution, the testimony offered by isolated and petty experiments formerly made, but had recognized its results in the operations now being carried on at Newport, county Mayo, in a district where every difficulty had to be contended with, and where, but three years ago, the cultivation of flax, except for most limited home use, was quite unknown. The only points now necessary to determine are, whether this process exerts any weakening effects on the fibre, and whether the linen made from it is as readily and as purely bleached as in the ordinary process; but if, after spinning, weaving, and bleaching, the linen from it be pronounced, by competent judges, as equal to that made from flax steeped in the ordinary way, I shall have no further hesitation in recommending the Committee to pronounce in its favor, believing that it is calculated to produce a complete revolution in the cultivation of flax in Ireland."

This process was, after several years of trial, recommended highly by the Royal Flax Society, at Belfast. The following description by Mr. McAdam, Secretary to the Society, was published in the report of the juries at the International Exhibition, 1851:

Simple wooden sheds contain the vats and drying shelves. In one end of the buildings are four vats; these are made of inch deal, fifty-six feet long, six feet broad, and four feet deep. There are false bottoms perforated with holes; underneath these are steam-pipes crossing the vats and having stop-cocks, to let on or cut off the steam as required. This is generated in a small boiler, which also works the two hydro-extractors, which drive off a portion of the water as the flax comes from the vat. The flax is packed in these vats on the butt end, half sloping, only one layer deep; then the water is let on, while a frame on top confines the straw in its position. The steam is let in by turning the stop-cock, and the water is eighteen or twenty hours in becoming heated to eighty-five or ninety degrees; when fermentation commences, no more steam is required, but the process continues forty hours, or sixty hours from the commencement, when the flax will be perfectly retted. If the water be heated before it is put into the flax, or if the temperature be raised above ninety degrees, the process is not hastened, but the fermentation is rather retarded. The gradual heating of the water is necessary if we wish to preserve the quality and color, and to have a uniform retting.

When thus retted, the flax is taken out and the vat is emptied and cooled for the reception of a fresh charge of straw, water, and steam, as before. As taken from the vat, the flax is placed in the hydro-extractor, where it is rotated rapidly to displace the water by the centrifugal force. From thirty handfuls placed in this apparatus, twenty pounds of water are expelled in from three to five minutes, so that a few hours suffice to treat the contents of one vat, amounting to two tons of the flax-straw. The flax is dried of its remaining moisture in the summer by spreading it upon the grass, but in winter it is spread thinly upon lattice shelves, protected by a shed that is heated by steam-pipes; the shed should hold the contents of one vat daily; when dried, the flax should be made up into small beets or handfuls suitable for feeding into the rollers of the breaking-machine.

Such an establishment can ret about ten vats per week, equal to twenty tons of straw, producing two and a half to three tons of fibre, thus making 120 to 150 tons of flax ready for market annually, the produce of 400 or 500 statute acres.

The saving in time accomplished by this process is not attended by any depreciation of quality or loss of material in the manufactured article. This is thus corroborated by the Belfast Society. The doubts raised as to Schenk's process were, first, that the yield of fibre would be less than the ordinary mode of steeping; second, that flax so prepared would be weakened; and third, that linen made from it would not bleach properly. Experience has proved that the last two are altogether baseless. As respects the first objection, we are of the opinion, that either by the common method or by Schenk's, the yield of fibre will be lessened if the fermentation be allowed to proceed too far. The uniformity of temperature insured by the latter would induce the belief that the yield of fibre should be increased.

The jury, in commenting on the various flax-fibres exhibited at the London Exhibition of 1851, made honorable mention, as follows: "The jury regret that the specimens of good flax from Ireland are so few in number. Those exhibited by Messrs. Bernard & Co., of Belfast, and retted on Schenk's patent hot-water steeping process, in sixty hours, are the best samples."

The Journal of the Chemico-Agricultural Society, of Ulster, said, January, 1853: "In Ireland, great expectations were entertained, that by the plans for this purpose, which were introduced by the late Mr. Schenk, the preparation of flax for the spinner would be made entirely a factory operation. In Ireland, however, the establishments erected under Schenk's patent have not generally given satisfaction. In England and Scotland, we are aware that the system has been more successfully carried out. * * * * Schenk's process, which is, in fact, merely the ordinary method of the farmer, regulated and accelerated, was, however, adopted by many persons but imperfectly acquainted with the various requisites of success." At the meeting of the Royal Flax Improvement Society, November, 1854, Mr. McAdam stated that he considered it still as the best method.

Notwithstanding the above satisfactory tests, the system has not grown into the general practice its merits seem to justify. One defect seems to be the labor necessary to place the straw in the vats and remove it; and as it was necessary to allow cooling before removal, much time was wasted, and the quantity, treated by a given number of pits, curtailed. This could be improved by having a number of strong crates, into which the flax could be placed, and the crates lifted into the pits by means of a traveling crane and pulleys, and lifted out by the same means after the maceration of the flax; whereupon a new crate could be substituted. I believe there is a field in this direction, for the treatment of both flax and hemp, promising great results.

The most perfect adaptation of Schenk's system was put in operation at the rettery of M. August Scrive, near Lille, France.* Tanks of wood or stone are used, each to contain two and a half tons of flax-straw, which is put in erect, the root-ends on a perforated false bottom, and slightly pressed together, but not so much as to prevent a free circulation of water, and a free exit for the gases germinated by the fermentation. The tank being filled with water, the whole is secured at the tops of the sheaves by narrow strips of wood four inches thick, catching the tops on the whole length of each row of bundles. These strips of wood are kept firm by cross-iron holders, secured by iron bars, fastened to pieces of wood worked into the side-walls of the tank, leaving a surface of four inches deep of water over the top of the flax. When the tank has been filled with cold water, the whole is rapidly heated to 78° Fahrenheit, by means of steam-pipes coiled under the false bottom. An open shoot carries heated water at 90° to discharge on the surface, besides two closed pipes, one

* Ure., vol. III.

of which brings hot water of the same temperature, and the other cold water. When fermentation sets in, which is ordinarily in eight hours, the pipe, as well as the shoot of water at 90°, is set at play; the first to create a continual current of fresh water through the mass of flax, clearing off the products of decomposition, and bringing them to the surface; the second to drive this foul water to the openings, where it is discharged by the overflow. The two pipes, with heated and cold water going to the bottom of the tank, as well as the two shoots containing cold and hot water to go to the surface, are also made use of to equalize the temperature during the whole operation, which is ascertained by the use of a thermometer. The "wet-rolling" between cylinders after the steep is accompanied by a shower of water at 70°, not on the flax, but on the top of the cylinders. This removes the remaining impurities, and prepares the flax for being easily dried and scutched.

WATT'S PATENT PROCESS.—An objection urged against the Schenk process was, that the small quantity of water used soon became saturated with the products of decomposition, and that the fibre of the flax, when dried, was consequently loaded with an offensive powder, causing inconvenience in the working of the same. This could be remedied by grassing; but Mr. Watt patented a process, in 1851, thought by many to be an improvement on Schenk's. Instead of fermentation, boiling, washing, and pressing were substituted. The following description will give an idea of this process:

The first operation consists in placing the flax, after the removal of the seed-bolls, in a chamber formed of plates of cast-iron. This chamber is about twelve feet long, six feet broad, and six feet deep, and contains about fifteen hundred weight of flax. On the top is a tank for containing water, also of cast-iron, about eighteen inches deep, the bottom of which forms the roof of the chamber, and through which passes a tube furnished with a valve. There are two doors in the ends of the chamber, through which the flax is introduced, after which they are closed, and secured with screws. A false bottom, formed of perforated iron plates, such as are used in malt-kilns, is raised about six inches from the bottom of the chamber, and, resting on this, there is an upright throw-pipe, the use of which will presently be seen. The chamber being filled with flax, and the doors secured, steam is admitted; and when the straw has been thoroughly saturated with moisture and softened, a weight is placed upon the valve on the top, so as to confine the steam, which, as it strikes on the cold bottom of the water-tank forming the roof of the chamber, is condensed, and made to descend in streams of distilled water, which dissolve the soluble matters of the softened straw, washing them into the lower part of the chamber, beneath the false bottom. The liquid, as it accumulates, is conveyed into a reservoir, and employed as a food for cattle.*

In from twelve to eighteen hours the steaming process is completed, and the straw, when withdrawn from the chamber, is immediately subjected, in small parcels, to the successive action of two pair of heavy iron rollers, by which it is pressed into flat, tape-like bands, and deprived of nearly all the moisture contained in it. The longitudinal pressure also removes a considerable portion of the epidermis or outer envelope, and

* This liquid possesses none of the disagreeable qualities of the ordinary steep-water. It is free from smell, and in taste and color somewhat resembles an infusion of senna leaves. It is, in fact, a strong tea, containing, unchanged by fermentation or putrefaction, the soluble matters of the stem of the flax-plant. At the factory of Messrs. Leadbetters, at Belfast, where the Watts system was practiced, this was advantageously used in feeding pigs. The following are the results of a chemical examination, by Dr. Hodges, of the water from the above named works. One gallon, evaporated to dryness, gave:

Of organic matters	353.97 grains.
Earthy and saline matters	161.49 grains.
Total solid matter	515.46 grains.

The organic matter afforded, on analysis, 14.79 grains of nitrogen. The earthy and saline matters were found to possess the following composition:

COMPOSITION OF THE ASH OF THE STEEP-WATER OF FLAX.

	Percent.	In a Gallon, Grains.
Potash	27.17	44.63
Soda	3.18	5.12
Chloride of sodium	21.58	34.61
Lime	5.91	9.49
Magnesia	4.60	7.40
Oxide of iron	0.83	1.33
Sulphuric acid	15.64	25.11
Phosphoric acid	5.66	9.01
Carbonic acid	12.43	19.96
Silica	3.00	4.83
	100.00	161.49

facilitates the removal of the woody matter in scutching. Each pair of rollers used exerts a pressure equal to ten hundred weight.

The straw was then placed in rooms with floors formed of spars; below this flooring passes a pipe conveying steam, by which the air admitted by the openings at the bottom of the chambers is heated, and made to ascend through the flax. The circulation of the air is ingeniously effected by a series of revolving beaters kept in action below the steam-pipe.

The following from the report of a committee of the Royal Flax Society, gives the result of an experiment made at Messrs. Leadbetter's works:

In this experimental trial a quantity of flax-straw, of ordinary quality, was taken from the bulk of the stock at the works, weighing 13¾ hundred weight, with the seed on. After the removal of the seed, which, on being cleaned thoroughly from the chaff, measured 3¾ imperial bushels, the straw was reduced in weight to 10 hundred weight 1 quarter 2 pounds. It was then placed in the vat, where it was subjected to the steaming process for about eleven hours. After steeping, wet-rolling and drying, it weighed 7 hundred weight 11 pounds; and on being scutched, the yield was 187 pounds of flax, and of scutching tow 12 pounds 6½ ounces fine, 35 pounds 3 ounces coarse. The yield of fibre in the state of good flax was, therefore, at the rate of 13½ pounds from the hundred weight of straw with the seed on; 18 pounds from the hundred weight of straw without seed; 26¼ pounds from the hundred weight of steeped and dried straw.

The time occupied in actual labor in the processes, from the seeding of the flax to the commencement of the scutching, was thirteen and one fourth hours. The scutching, by four stands, occupied six hours sixteen minutes. In this statement the time of drying is not included, as, owing to some derangement of the apparatus, no certain estimate could be made of the actual time required in that process. It would appear, however, that about thirty-six hours would include the time necessary, in a well-organized establishment, to convert flax-straw into fibre for the spinner.

The cost of all these operations, in this experiment, leaving out the drying, for the reasons noted, appeared to be under £10 per ton of clean fibre for labor, exclusive of general expenses.

A portion of the fibre was sent to two spinning-mills to be heckled, and to have a value put upon it. The valuation of the samples varied from £56 to £70 per ton, according to the quality of the stricks of fibre sent, and the yield of the heckle was considered quite satisfactory.

It is to be hoped that so promising a plan may, on more extended experience, be found fully to warrant the high anticipation formed from what is already known concerning it.

(Signed on behalf of the Committee.)

RICHARD NIVEN, *Chairman.*

BELFAST, 3d Nov., 1852.

Professor Wilson, an authority on flax, said on this system: "Here we have a process which presents the following advantages over the ordinary methods: First, great saving in time; second, economy of fibre; third, avoidance of any nuisance, and beneficial application of waste product."

Dr. Hodges, in a paper read before the British Association for the Advancement of Science, in 1852, commended this process highly, and said: "A striking peculiarity of this process, and one which renders it exceedingly interesting to the scientific agriculturist, is, that it offers the only satisfactory method of economizing the matters which are dissolved from the flax-plant in its treatment. The dark liquid which accumulates in the lower chamber of the vat can be obtained in a most concentrated form. It is totally free from the disagreeable odor of the flax-pool, and experiments which have been tried prove that it is found by pigs a palatable and nutritious food."

Watt died in 1858, since which time his process has been little practiced. There is evidently much good in it, and it is to be hoped that it will be tested, in this country, on flax and hemp, with some modifications.

BUCHANAN'S PROCESS.—Soon after the introduction of the Watt's system, another process was patented by Buchanan,* which was thought to be an improved application of the same principle as Watt's. In this process, the steeping is effected by repeated immersions in a tank of heated water, arrangements being made by which the temperature is not allowed to exceed a certain degree—a point of importance, as fibre is thought to be injured if exposed to a heat beyond a certain temperature; and albuminous solutions, containing only a small proportion of albumen (1 in 1000) coagulate at a temperature of 180°, and then become insoluble. In Buchanan's process the temperature of the water is kept between 150° and 180°. The process is performed by automatic arrangement of simple and inexpensive construction, thus saving labor and insuring regularity of manipulation. Only four hours were required for the completion of the steeping. Great improvements were also claimed in the method of drying, preparatory to scutching.

POWNELL'S PROCESS.—In his experiments on flax-straw, Pownell discovered that if the straw be taken out of the steep-water after fermentation, and at once subjected to severe pressure between a pair of smooth cast iron rollers and a stream of cold water, the pressure pressed out all of the gluten not removed by fermentation, and the water washed it away. This evidently was a move in the right direction. By this means, fermentation need never be carried beyond the safe point, and if the flax be well cleaned of gluten, the scutching can be easily performed, as the separation of the fibre from the wood will not be retarded. The yield would be greater, and the value of the flax enhanced.

BURTON & PYE'S PATENT PROCESS.—After rippling, the flax-straw is passed through a machine with plain and fluted rollers, by which the woody part is crushed, and as much as

* For full description of the Buchanan process, see Prof. Wilson's paper in Journal of Agricultural Society, Vol. XIV.

possible separated from the fibre. It is then placed in a vat holding about a ton, and the vat is filled with cold water. Steam is introduced under a pressure of 50 pounds to the square inch, and disseminated through perforated tubes, under a false bottom. Another tube conveys into the vat a cold mixture of fuller's earth in water; which is continued until the steam raises the temperature in the vat to 80° Fahrenheit. The flax remains at this temperature for 30 hours, when it is covered with a soponaceous froth. The impurities are expressed from the fibre by two powerful screws, working on a frame of wooden cross-bars, closely fitting the interior of the vat. Cold water is supplied with the steam, and the temperature increased to 150°, the pressure continuing until the water appears free from impurities. The water is then withdrawn through a valve in the bottom of the vat, and a pressure of 200 tons is applied for four hours to the flax. It is then taken out and dried in open sheds. A similar process, with some modifications, invented by M. Terwangue, of Lille, has been tried in France.

There is an old German process, called "molkenrost," sometimes used in the preparation of the finest kinds of flax. This consisted in steeping for four or five days in a mixture of warm milk and water.

There are other processes of more or less merit for retting flax, but the ones described are sufficient to give an idea of the principal efforts, and serve as hints to experimenters in the future.

Of the various chemical processes, the only ones worthy of mention (on account of the wide-spread expectations in this country and in Europe, and the consequent disappointment and loss) is the Claussen process, patented by the Chevalier Claussen, a Belgian gentleman, in 1850. By this process, the flax or hemp was broken before retting, and the broken stems were boiled in a diluted solution of caustic soda, containing about one two-thousandth part of alkali. The fibrous matter is then removed, and plunged into a bath of dilute sulphuric acid, of one five-hundredth part of acid, in which it is boiled for about an hour. Next it is put into a solution containing ten per cent. of carbonate of soda, where it remains for about an hour; and then the process is completed by putting it for about half an hour into a solution of sulphuric acid, of from two to five hundred parts water to one part of acid.

By this method a material much resembling cotton, and susceptible of being spun on cotton machinery, was produced.*

A Mr. Jennings, of Cork, Ireland, found that by boiling the flax-fibre in an alkaline soap lye, washing it with water, and then boiling in water slightly acidulated with pyroligneous acid, which decomposes the soap, and leaves its fatty constituents on the fibre, the fibre, after again washing, is found to be soft and silky, and readily divisible on the heckle into very fine fibres.

A search through the reports of the United States Patent Office will bring to our knowledge numerous patents for the treatment of flax and hemp in the separation of the fibre from the woody portion of the stem, some of which have been put into practice in various parts of the country. I will attempt to describe none of these,† because I find the principles involved in all I have examined but modifications of those described in the preceding pages. The reports of the Patent Office are easily accessible to all who may wish to gain what information they may afford on this subject; so that a detailed description here would be superfluous.

Notwithstanding the patent processes, flax and hemp, in the preparation of the fibres for the manufacturer, are treated more nearly in the ancient simple methods than other articles of manufacture, and I believe the best results are obtained from these old-fashioned, long-practiced methods.

BREAKING.—The object of retting is to dissolve and wash out the gluten, and render brittle the woody stem, so that it can be broken and shaken out and separated from the fibre by the scutching. Most primitive methods of accomplishing

* For further information about the Claussen process, see pages 91–5.

† Except the Barlow process, see page 167.

this are yet in practice all over the world—even in districts where flax and hemp have been grown for centuries.

In the north of Ireland the flax is sometimes broken by spreading upon a hard smooth road, in two rows or swaths, and loaded carts driven over it, the horse passing between the rows, the flax being turned and shifted out and in under the wheels by children. In Flanders and portions of France, the flax-straw is sometimes spread evenly upon a floor, and the workman, placing his foot upon it, beats it with an instrument called a "mail,"* consisting of an oblong block of hard wood, fluted on the under side, to which is attached a curved handle, as seen in Figure 5. This is called in Ireland a "Bott-hammer."

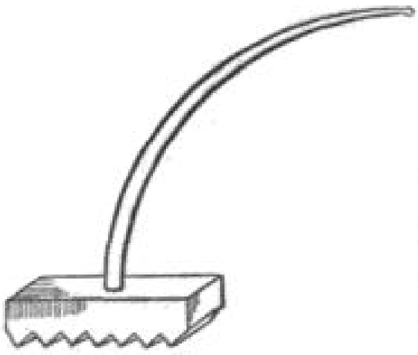


Fig. 5.

Another method is by a millstone attached to a horizontal pole, which is fastened to a central upright shaft. The stone is made to traverse on a hard circle, on which the flax is spread, about six inches thick. This is a very economical and effective method. A similar method was formerly used in Kentucky, called "milling," for softening the hemp-fibre preparatory to spinning it.

To the farmer only growing a small patch of flax for domestic manufacture one of the above methods, or the hand-brake, similar but smaller than the hand-brake for hemp now universally used in Kentucky, will answer his purpose.

The accompanying figure will show the construction of such a brake. It should be made of hard wood. The head (4) is about 10 inches long by 3½ inches thick, flat on the under side. From this to the socket-piece (S) is a pole (P), which is used as a handle to operate the brake. This should be constructed so as to spring and prevent jarring the hand. The slats or blades (T) are wedge shape, the inner edges thin, but rounded so as not to cut the fibre. It would be better if they were placed further apart at the back end (not

* This process, yet practiced, was described by Louis Crommelin, as an improved plan, in A. D. 1705.

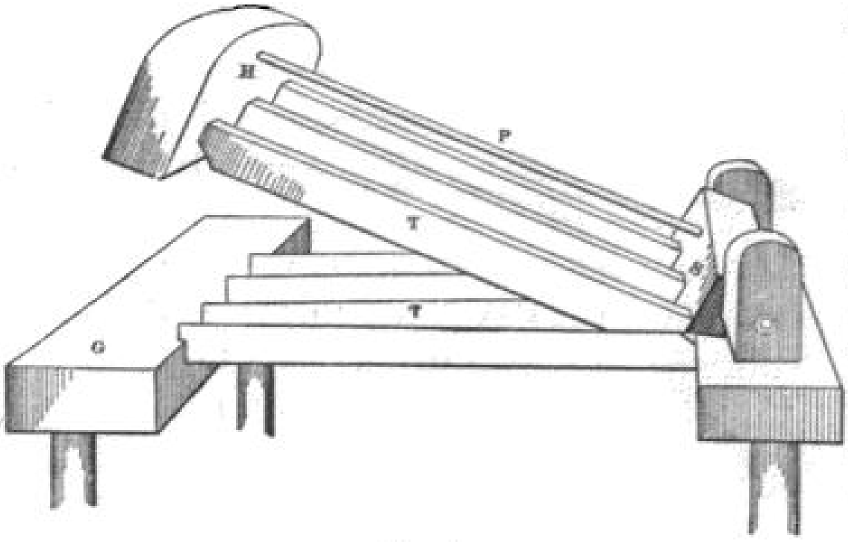


Fig. 6.

so shown in the figure), so that the straw could be broken in short or long length as desired. Three feet long would be about proper for a flax-brake. Of course, the hemp-brakes are longer.

Such a brake could be constructed by any one with a limited experience in working in wood. Figure 7 is a somewhat

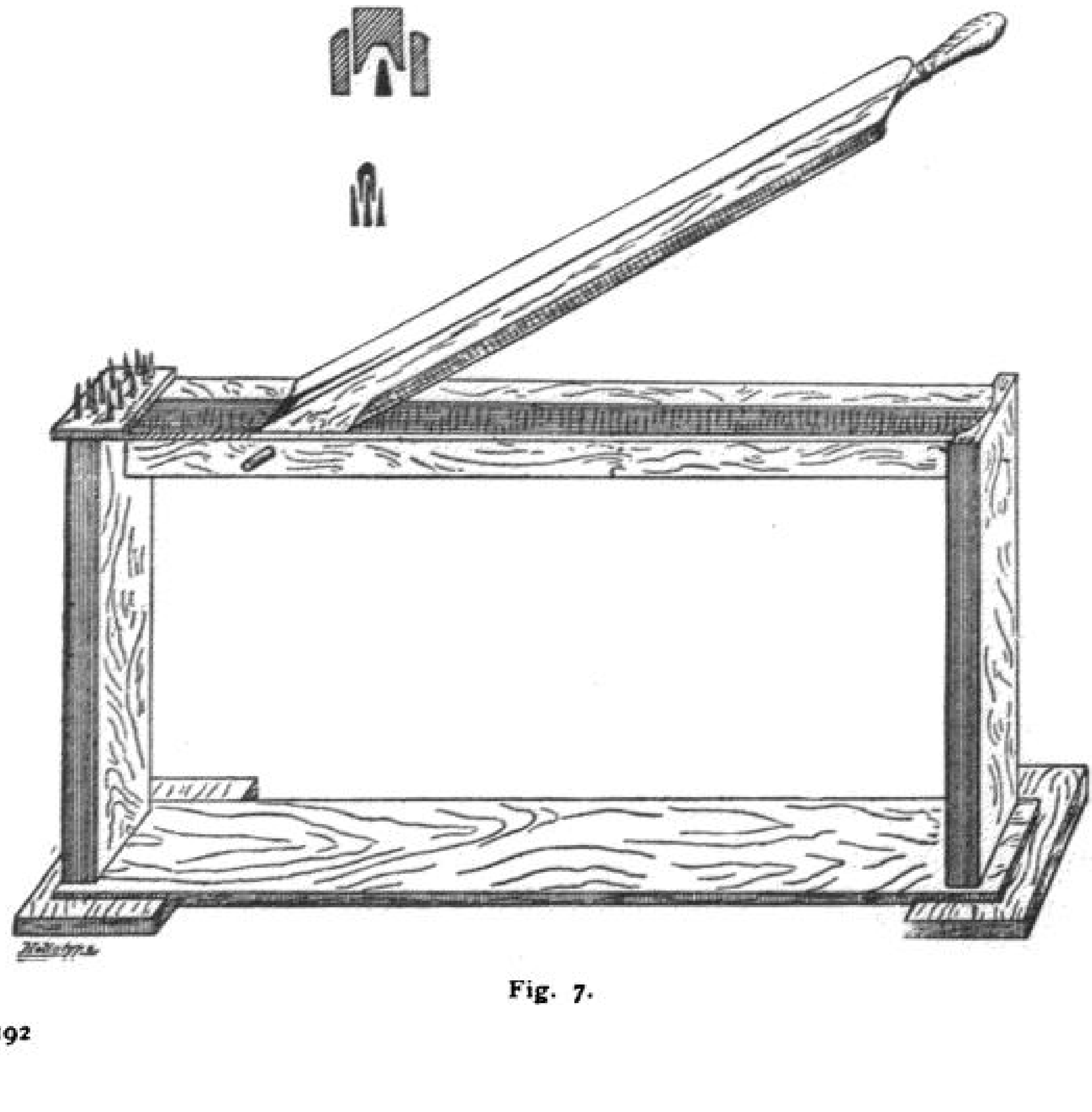


Fig. 7.

similar brake used in the Netherlands, but it is not so good as the one just described. The handle is in the wrong place, as it would be inconvenient to raise the brake and put the flax between the blades, the body of the workman necessarily being advanced too much to the front, which would not be the case in grasping the handle (P, Fig. 6) near its centre.

The roller-brake is evidently the best for flax, and the one most universally adopted. In a paper read before the Irish Flax Society in 1843, it was said that "wooden rollers, lightly grooved, break flax better than any method I have yet seen."

Numerous roller-brakes have been patented in this country and in Europe, and I herewith present a description of those most generally approved.

Figure 8 is a cheap revolving-brake, of simple construction.

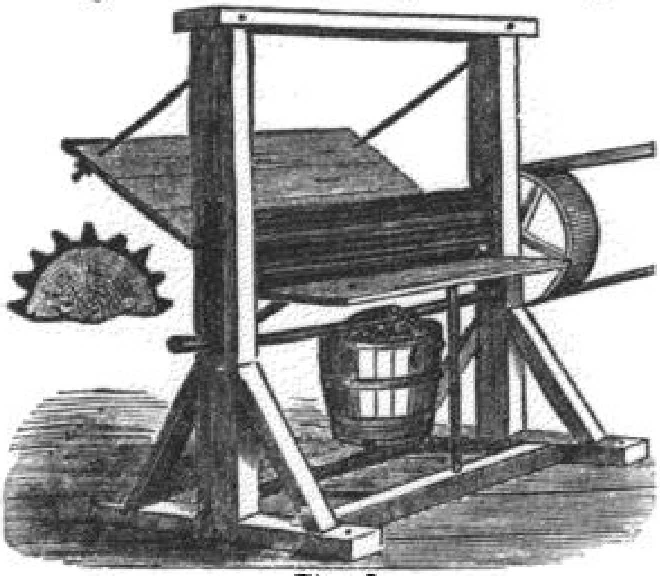


Fig. 8.

The rollers are about six inches in diameter, of cast iron, with flutes, or of hard wood, fluted, or of wood, with iron ridges screwed on, as shown in Figure 8. The driving pulley is attached to the lower roller. The bearings of the upper one play up and down in slots three or four inches long. Iron bands pass over the gudgeons of the upper roller, and support a pole, on which is a tub to be filled with stone to give the desired weight to the roller. This is the simplest form of roller-brake. It can be run by horse-power, if steam or water-power is not available. It will be necessary for a man to receive the straw as it passes from the machine, and pass it back to the feeding-table, so that it may be passed through several times. This is not necessary in the machines hereafter described. Figure 9 represents a flax-breaking machine manufactured in England, suitable for small cultivators. It has two pairs of fluted iron rollers, driven by strong gearing. On front of the machine are two brackets, which carry a table, on which the flax straw is placed. It is fed by hand between the first pair of rollers. These draw the straw in and pass it on to the second pair of rollers, the flutings of which are finer than those of the first pair. The straw is thus crimped and broken by being pressed between the flutings of the rollers; the fibre, from its tenacity, remaining intact, but the woody portion, being brittle, is broken in pieces and flattened in such a manner as to cause a great portion of it to drop off whilst in the machine. The remainder is removed by the subsequent scutching. The bearings of the top-rollers work in slides, and are free to move upwards in order to adapt themselves to the varying thickness of the straw passing through the machine. The requisite pressure on the rollers is obtained by means of india rubber rings placed in recesses on the tops of the sliding bearings, and kept down by cross-bars. The top rollers are driven from the bottom ones by deep-toothed wheels. This driving of the top rollers by gearing, instead of by contact between the flutes, is thought to be an important advantage.* This machine can be made with fly-wheel, and an arrangement to be worked by hand-power, at an extra cost of 35 shillings. It is claimed, that in the machines constructed so that the top roller is driven by contact with the

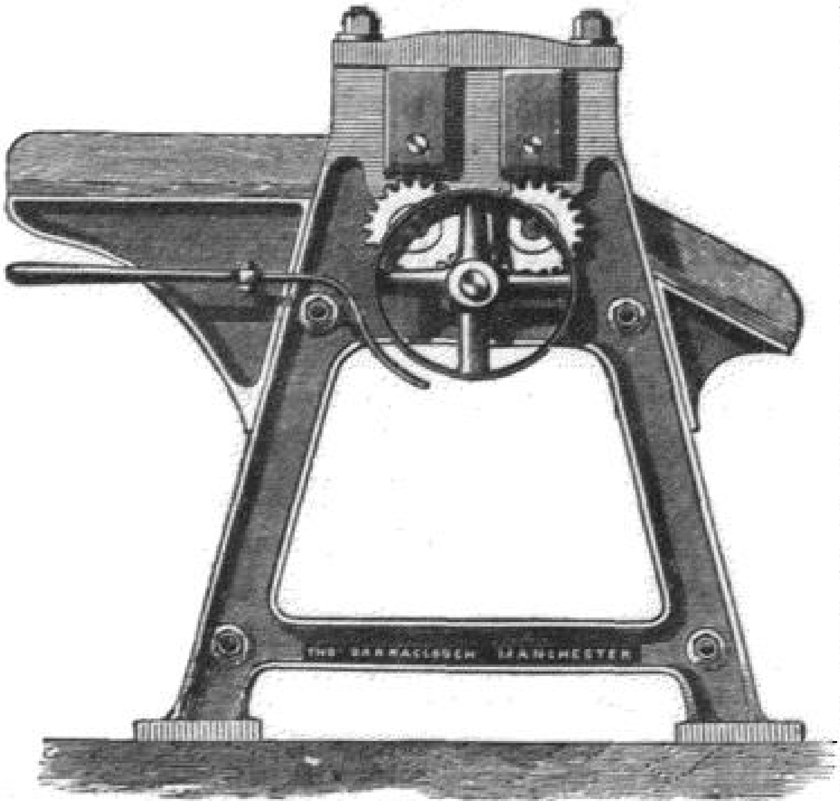


Fig. 9.

* The cost of the above described machine (Figure 9), delivered in New York, freight and duty included, will be about $155.

This page in the original text is blank.

PLATE I.

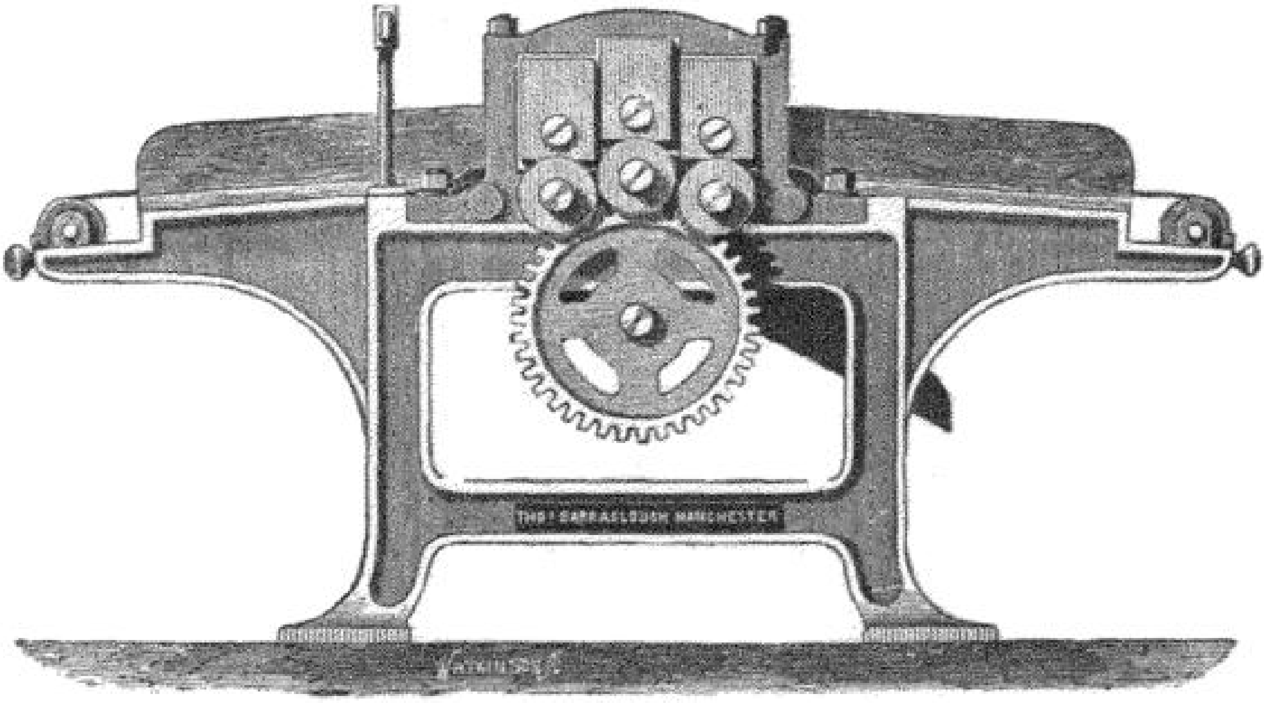


Fig. 1.

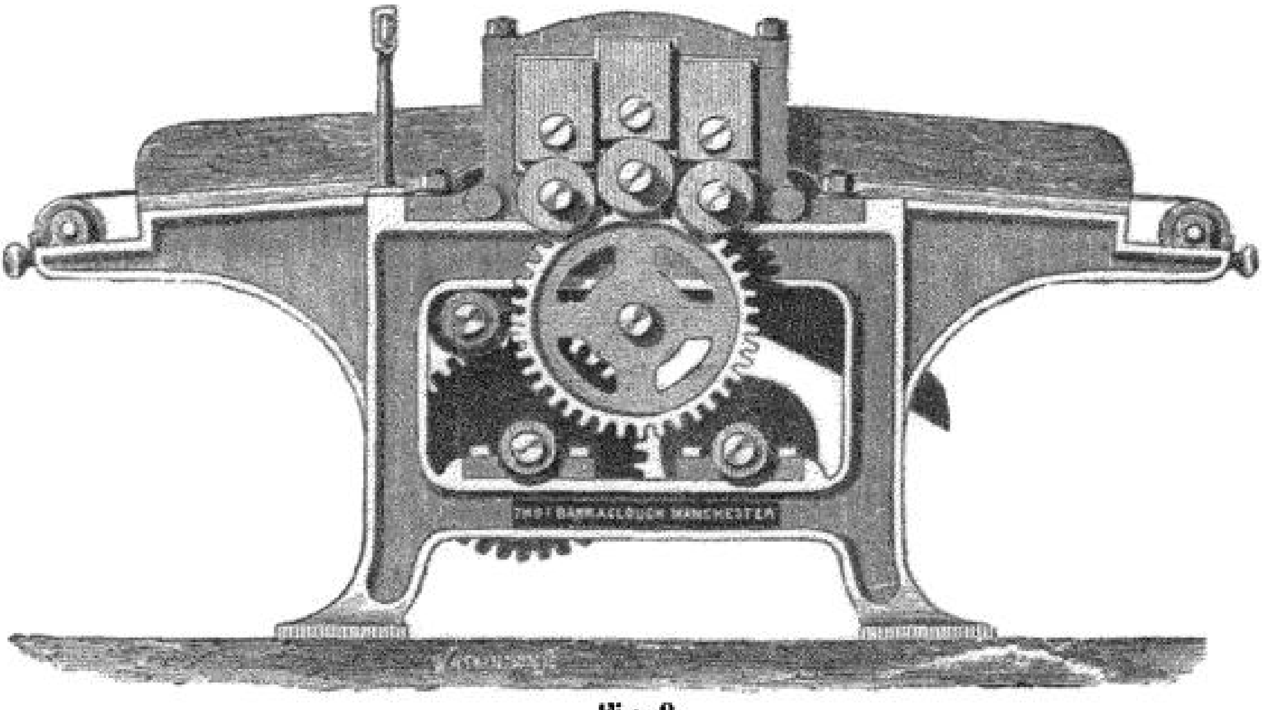


Fig. 2.

flutes of the bottom roller, the fibre, together with the broken shives, is ground between the shoulders of the flutes, and thereby deteriorated, and an excess of waste fibre or tow is produced in the scutching.

Breaking-machines are sometimes constructed with one large fluted cylinder, and from three to six small fluted rollers working on and in contact with it; the breaking is done between the cylinder and the rollers. The flutes are all necessarily of the same pitch, consequently the flax-straw is always broken in the same places. The effect produced by such a machine is, therefore, little more than produced by one pair of fluted rollers.

Figure 1, Plate I, represents a larger and stronger breaking-machine, similar in action and construction to Figure 9, suitable for large scutch mills. It is claimed for this machine that it will break either flax or hemp. This machine has three pairs of fluted rollers, the flutes of each pair varying in pitch. There is an endless feed-apron and an endless delivery-apron. The shives, as they fall during the breaking process, drop onto a shoot underneath, and thence to the front of the machine.

To this machine can be applied a reciprocating motion, shown in Figure 2, Plate I, by means of which the rollers are made to revolve, in a forward direction, for a given distance: their action is then reversed, and they rotate back for a portion of that distance. The flax or hemp-straw, therefore, on entering the machine, is subjected to a forward and backward motion, the former being always in excess of the latter, so as to cause the straw to pass gradually through the machine. The production of the machine is reduced by the application of this motion; but its breaking and bruising action on the straw is greatly increased. This motion is very beneficial in all cases in which the straw is of strong growth and coarse, requiring much breaking preparatory to scutching.*

The brake most in use in the flax-growing districts of the United States and Canada is the Mallory & Sandford patent.

* The above machine, made very strong and heavy for hemp or flax, and arranged to be worked by steam or horse-power, will cost, laid down in New York, freights and duty included, about $240. This includes a duty of 35 per cent.

manufactured by the Flax and Hemp Machine Company, Jno. W. Quincy, Treasurer, New York. Several sizes of brakes are made by this firm.

Figure 10 represents a six-roller brake, rolls three inches in diameter, thirty inches long. A stronger brake, with four rolls, six inches in diameter and thirty-six inches long, and one with four rolls, eight inches in diameter and four inches long, is made. It is claimed for this brake that the straw requires very little after-scutching; that the yield of fibre is larger than by other methods. The illustration is sufficiently explanatory of the method of working this machine.

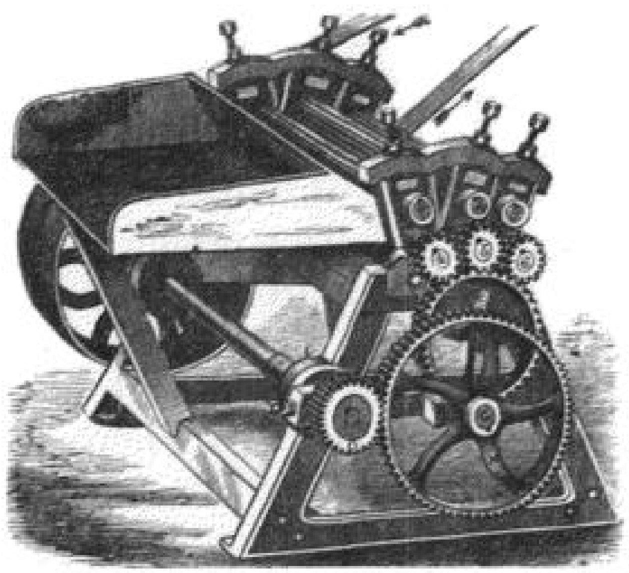


Fig. 10.

A committee appointed by the New York State Agricultural Society, to examine into the merits of flax-machinery, reported as follows:

That they had carefully examined the Mallory & Sandford flax-brake, and tested it in a very great variety of circumstances.

Experiment 1st.—10 pounds 3 ounces of unretted straw, precisely as it came from the field, was passed through the breaking machine. The time occupied was 2 minutes 50 seconds, and the weight, after breaking, was 6 pounds 10 ounces. The scutching process occupied 6 minutes, and the flax weighed, after scutching just 2 pounds.

Experiment 2d.—10½ pounds dew-retted flax (half retted) was passed through the breaking-machine. The time occupied in the process was 2 minutes 50 seconds, and the flax weighed 5 pounds. It was scutched in 9 minutes, and the yield of clean fibre was 2 pounds 3 ounces.

Experiment 3d.—21 pounds 1 ounce of thoroughly-retted (dew-retted) flax-straw were passed through the machine in 3 minutes 50 seconds, and weighed 9 pounds. The broken straw was scutched in 8 minutes, yielding 4 pounds 14 ounces of clean fibre.

The average work of the machine during the three trials was 1.558 ounce per second, which, at 10 hours work per day, would be equivalent to 2,668 pounds of flax-straw. The total weight of broken straw in the three experiments was 20 pounds 10 ounces, which was scutched in 23 minutes 50 seconds, which is equal to 0.772 ounce per second. Running for 10 hours, a scutching-machine will dress 1,737 pounds of broken flax-straw.

It, of course, would be difficult to work the machines regularly as fast, or do as much work with them as was done at these trials; but the committee had no doubt that the brake could run through 2,000 pounds of straw daily, and that two scutching-machines would dress the flax as it was broken by the first machine. Six-horse power would be ample to run the brake and the two scutchers.

The unretted flax in these experiments yielded 18.9 per cent. The half-retted yielded 21.9 per cent., and the well-retted yielded 23.1 per cent. of dressed flax.

The committee further stated that the machine of Mallory & Sandford did the work with less power than any other; that it detached more of the worthless from the valuable portions of the straw than any other; that it wasted less, no fibre being detected in the shive after the experiment.

The Mallory & Sandford brake has been used in Ireland, giving satisfaction. I am informed that some of the Irish scutch-mills are supplied with these brakes.

Another brake, known as the Randall brake, has fluted rollers, and is used in some of the scutch-mills in this country.

The most recent flax and hemp-brake is a French machine invented by N. de Landtsheer, of Paris, France. The patent has been purchased in this country, and the machine manufactured and sold by the "American Vegetable Fibre Company," Philadelphia, Pennsylvania. It is claimed for this machine that it will break either long or short stalks, flax or hemp, scutching it at the same operation; also, that it will break and scutch to any desired degree.

Figure 11 is an illustration of this machine. A detailed description can be seen in the "Official Bulletins of the United States Patent Office" for May, 1877, pp. 381–4.

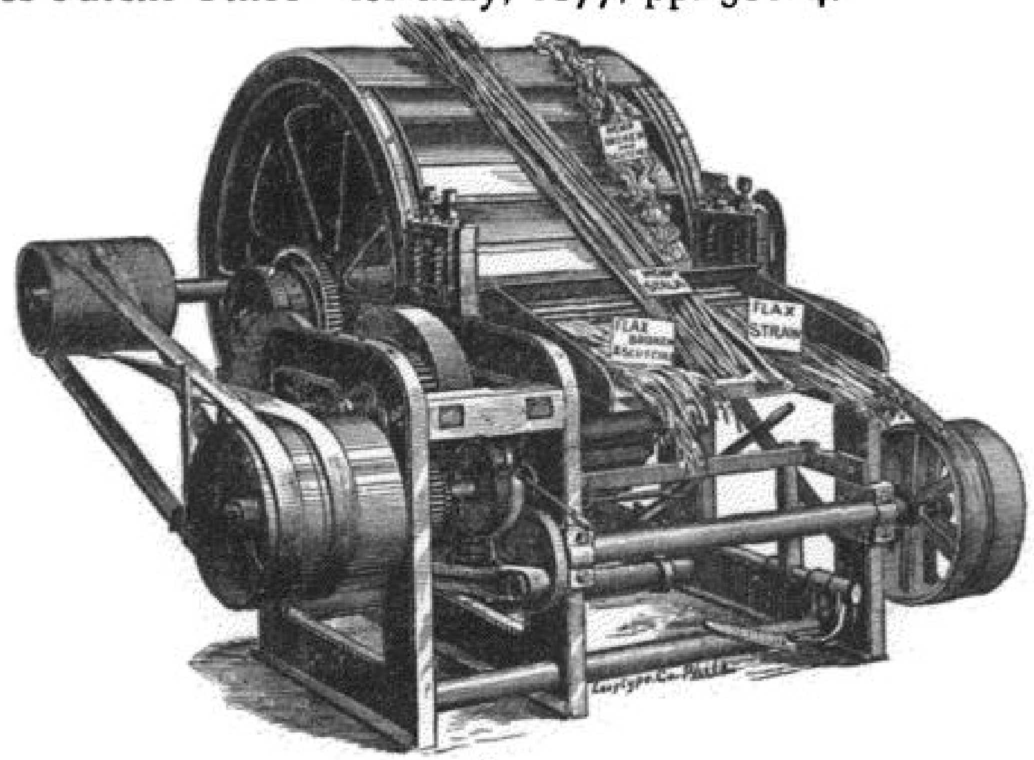


Fig. 11

The following from Committee on Science and Arts of the Franklin Institute, Pennsylvania, making the award of Elliot Cresson gold medal, describes the working of this machine:

HALL OF THE FRANKLIN INSTITUTE, PHILADELPHIA, Dec. 19, 1878.

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania, to whom was referred for examination Norbert de Landtsheer's machine for treating flax, hemp, and other similar plants, report that the machine occupies a floor-space of about 8x10 feet, and consists of a cast-iron frame, a stationary feed-board or table, two pairs of fluted metal rollers, a sheet-iron drum or cylinder furnished with blades or beaters of wood at regular intervals around its circumference, and the necessary driving pulleys, wheels, pinions, and gears for automatic operation. In outward appearance it somewhat resembles a grain-fan.

Two distinct operations upon the staple to be treated are performed by this machine: the first, that of breaking; the second, of scutching. The object of the first is to break the stem or "boon" forming the woody interior of the flax or other similar fibrous plants, that this refuse may more readily be removed in the subsequent operation. The second is to beat or scutch out this "boon" or broken straw, thus leaving the fibre in a condition to be mechanically divided in the heckling-machine or gill-box.

In operation, the stalks of hemp or flax which had previously undergone the process of "retting" or rotting, were placed upon the feed-table of the machine, and fed to the first pair of fluted rollers or cylinders in the direction of the fibre's length. These fluted rollers are each supported in journal-boxes, which allow the teeth or flutes to mesh, but prevents them from coming in contact at the bottom of the flutes. To these rollers or cylinders is imparted, by suitable mechanism, an *alternate circular* motion, forward in the direction of the scutching-drum, and backward in the direction of the feed-table, the forward motion being the greater. This, while imparting a reciprocal movement to the fibrous stalks, thus effectually breaking the "boon" or woody interior, at the same time carries the "strick" or broken portion forward to be still further operated upon by the scutching-drum or cylinder. This drum is of sheet-iron, affixed to cast-iron rims or spiders, is four feet in diameter, and is furnished with sixteen tough wooden blades or beaters. It revolves in an opposite direction to the forward motion of the breaking-rollers, that is, the upper periphery of the scutching-drum moves in the direction of the feed-end of the machine, thus bringing its beaters, with a downward blow, against the pendant fibres, beating out the "boon" or broken woody interior This operation is still further aided by the current of air set in motion by the revolution of the drum, which winnows the chaff from the long lines of fibres.

When the stalks have been fed between the fluted rolls to a little beyond the centre of their length, the alternate circular motion is converted automatically, or by hand, to a rapid, continuous *reverse* motion, which delivers the strick to the operator, who then feeds the unbroken stalk-ends to the breaking-rollers. These, in turn, undergo the above described operation, and the fibre is discharged as before, free from straw or boon, and in straight untangled lines.

The mechanism designed to impart the alternate circular and continuous reverse motions to the fluted rollers consists, in its essential features, of a concentric pinion-wheel brought into alternate working contact with cogs on the concave rim of a surrounding gearing, and a system of crossed and open belts. *This mechanical contrivance is deserving of special mention, being well adapted for the purpose designed*, is capable of adjustment to suit different lengths of fibre, and may be controlled automatically or by hand. The flax-stalks operated upon were grown not for the fibre but for the seed alone, and had not been properly "retted," yet the machine under consideration performed the operations of breaking and scutching with entire success. Flax-stalks two feet, and hemp-stalks eight feet long, were alternately fed to the machine, and the fibre was delivered, clear of "boon," straw, and woody material, in from thirty to forty seconds, while but very little scutching tow or codilla was made.

The machine is rapid in its action, not complicated with delicate and nicely-to-be adjusted parts, requires comparatively little power to drive it, and does not need skilled labor to operate it. It is a French invention, and letters patent have been granted in England and the United States, the former bearing date May 30, 1874, and designated by No. 1900, the latter May 8, 1877, and numbered 190,476.

The introduction and general use of this machine would, without doubt, tend to restore and extend the cultivation of such fibrous plants as flax, hemp, jute, and others of a similar nature, by enabling producers to deliver these several fibres in a clean, straight, long line, and marketable shape, at low cost.

Unlike cotton, which is comparatively a delicate plant, that can only be grown profitably in the Southern and Southwestern States, flax and kindred plants may be grown readily throughout our entire country. Light soils are more suitable for its development, but good crops may be gathered from strong and clayey ground. Hitherto the operations of breaking and scutching have been largely performed by hand; and where machinery has been used, each operation requires a distinct and separate machine. Rude in design and imperfect in performance, they have, even in flax-growing districts, scarcely supplanted the primitive methods, while in this country they are almost unknown.

Your Sub-committee, therefore, respectfully submit the above, and believe this machine to be a valuable and useful improvement, worthy of award.

[Signed] STOCKTON BATES, *Chairman.*
CHAS. H. BANES,
C. MILNE,
JOHN SHINN, *Sub-Committee.*

True copy:—D. S. HOLMAN, *Actuary and Secretary pro tem.*

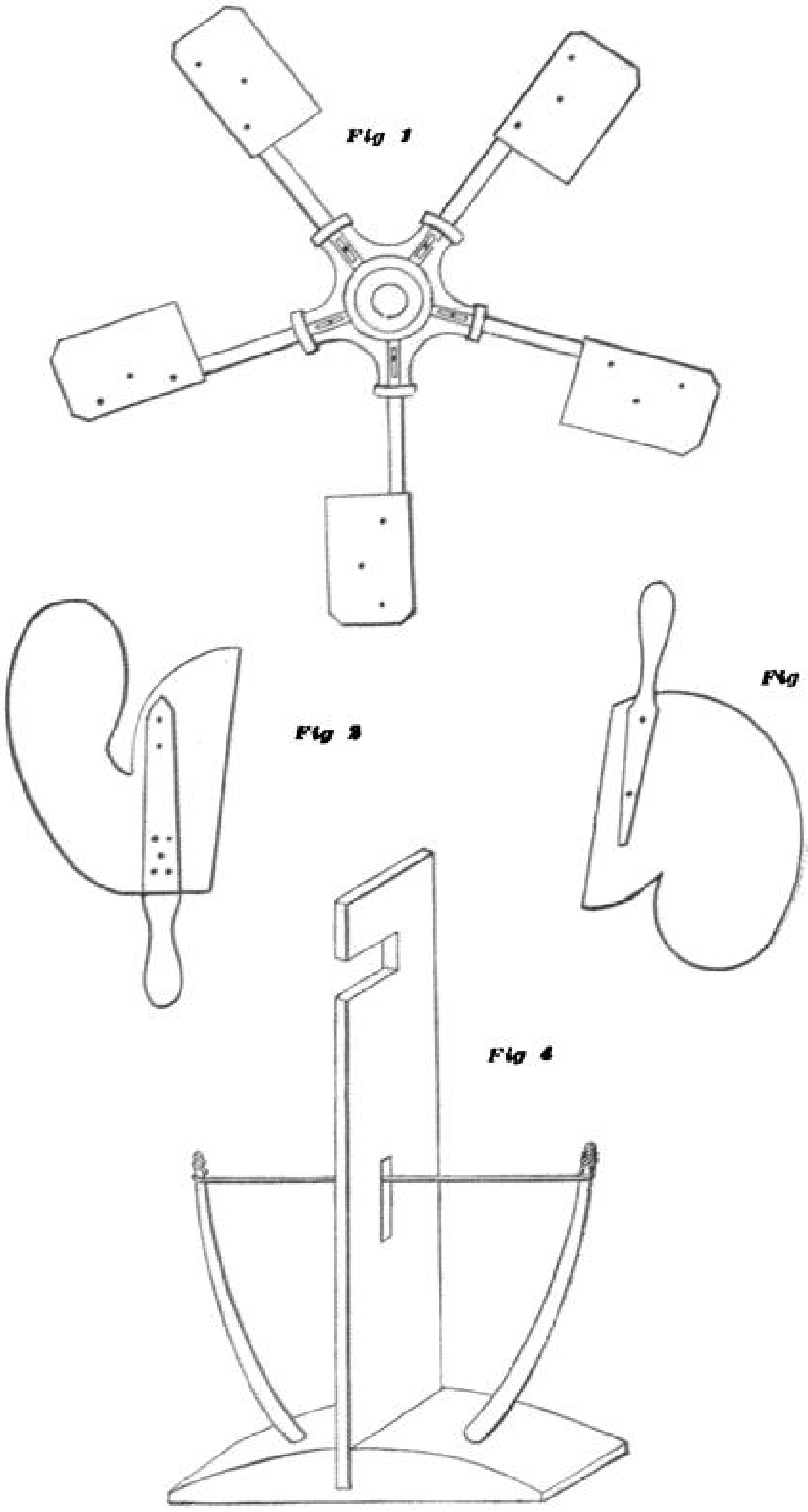
Arrangements have been made to have this machine tested in the hemp-growing district of Kentucky, and I hope to be enabled to give, in an Appendix, the result of the tests. If it will accomplish what is claimed for it, it will be of great benefit to the flax and hemp interests of this country.

I might have given descriptions and illustrations of other breaking-machines; but I believe the ones given embody the best results obtained in the many attempts at perfection in this line.

SCUTCHING.—Most of the flax raised by small growers is scutched by hand, and there is yet a large amount of flax hand-scutched in the old growing districts of Europe. Figure 1, Plate II, represents the best form of scutching-blades, driven by power, used in Europe; Figure 2, a scutch-knife from Belgium; and Figure 3, one from Germany.

In scutching, the broken flax is held in the left hand, through

PLATE II.



the slit in the board (Figure 4, plate II), and with the knife (Figure 2 or 3, Plate II) it is repeatedly struck, parallel to the board, and close to the slit, the flax being changed and opened out continually by a motion of the hand. It is important that the knife be wide, as represented; when narrow, the flax-straw twists round it, and becomes tangled and broken. The blade of the knife should be made of tough hard wood. The strap which fixes the board to the uprights gives an elasticity, which is desirable. When the flax has been well retted and broken, all of the shive or boon can be removed by this process.

The first trial of machinery in scutching was the construction of an axis, with horizontal blades attached, which worked inside a circular box, with an opening in the top, through which the flax was introduced. This did not prove successful, as there was too much waste. The most successful machines now in use are an application of power to the hand-system above described—wooden blades attached to a horizontal shaft, acting on the flax vertically. Figure 1, Plate II, represents such a system of blades as is in use in Germany and elsewhere on the Continent. The scutch-mills most generally in use in Europe are constructed as follows: A horizontal shaft, of a length sufficient for the number of "berths" required, is fixed in bearings against a row of pillars. On this shaft are fixed, at intervals of about two feet nine inches, wheels, technically called "wiper-rings." Each of these rings carries a number of blades, as shown in Figure 12. Parallel with the shaft is placed an iron partition, bolted at the bottom, and connected at the top by a bracket with the post, as shown in the illustration. The scutching-blades work in openings in this partition. These projections are also of iron, and are covered by suitable iron casings. One side of each projection is plain, and the other side has a wedge-shape opening in it; the lower edge of this slot is horizontal, and slightly higher than the wiper-shaft. The front covering or casing of each projection extends only down to this opening, in order to allow the admission of the flax-straw. The wiper-rings are fixed on the shaft at intervals of about two feet nine inches. The iron projections are nine inches wide; thus each workman has a space, usually called a "berth," of two feet to stand in between each projection. The object of the partition is to cause the woody boon, dust, tow, &c., to fall in the places prepared for it, on the same side of the partition as the main shaft, the floor on that side being much lower than on the side where the operator stands, this giving room below the blades, and facilitating the removal of the waste and tow.

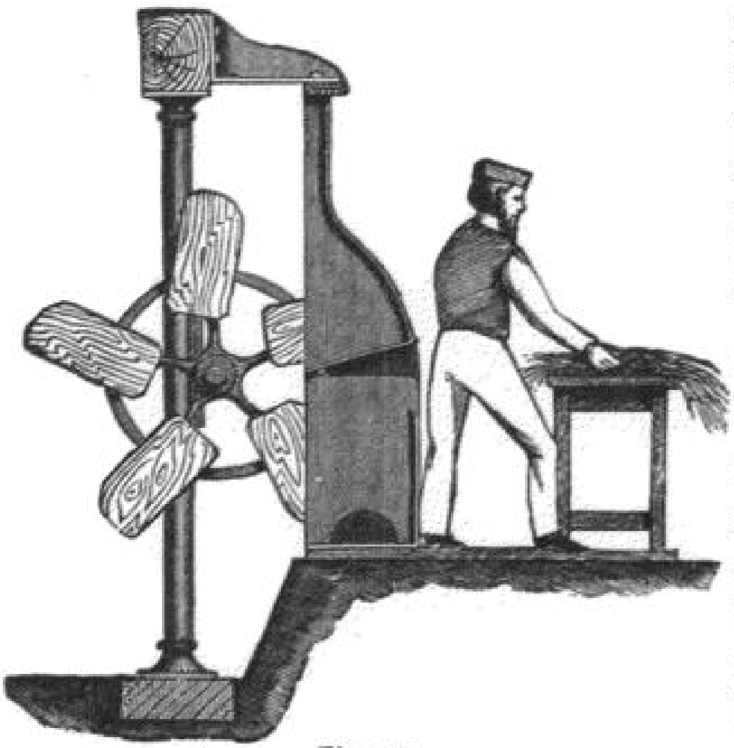
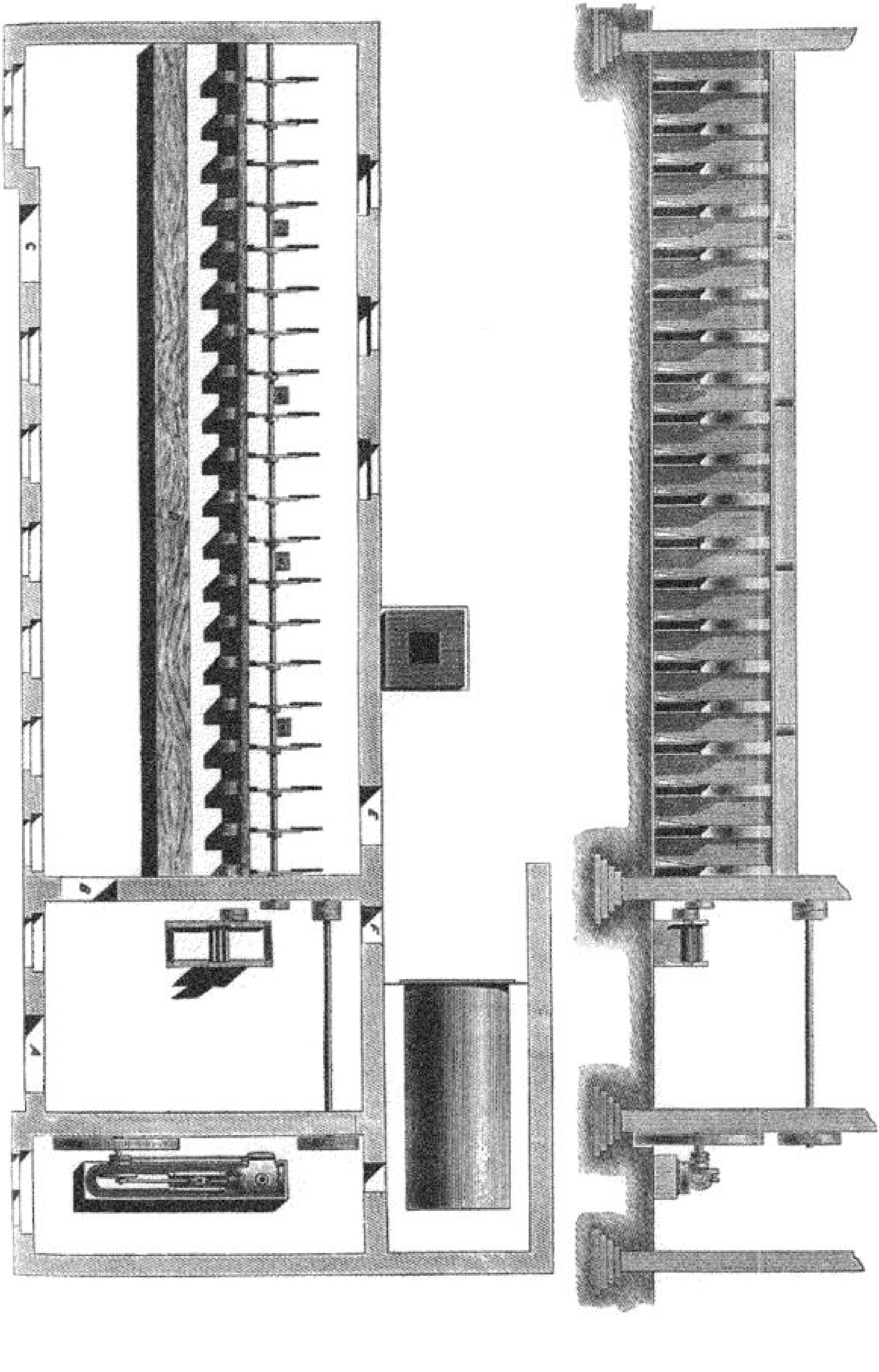


Fig. 12.

The partition and projections are usually made of iron, to lessen the danger from fire. A mill constructed in this way will also be free from dust on the side of the partition where the workman stands. On Plate III is a ground plan and elevation of a scutch-mill containing twenty "berths" or stocks, such as has just been described. The dry flax-straw is brought into the building through the door *A*, and passed through the roller-brake from the feed-end, which is nearest the door *F*. After the straw has been broken, it is passed through the door *D*, and placed in handfuls, called "streaks," on the table *D*, which has the top hinged in various places to allow the workmen to pass through. Each workman stands in his "berth," with the slot in front of him, with his left hand against the partition; he takes a streak of broken straw from the table, and inserts one end into the slot through the uncovered part of the projection, resting the middle of the streak on the bottom edge of the slot, and sliding it gradually forward, bringing it under the action of the scutching-



This page in the original text is blank.

blades, which strike it in the direction of its length. When the shive has been beaten out of the flax, it is withdrawn, and the other half inserted, to be similarly treated. The workman then passes the handful of flax, which has been roughly scutched, to his neighbor, where it is finished by a repetition of the process. The scutching-blades in the second operation are set closer to the slot than in the first, and consequently the flax is more thoroughly scutched. The woody portion removed in breaking and scutching answers for fuel to heat the boiler, and is quite sufficient to generate all of the steam required to drive all of the machinery required in a scutch-mill. It is thought that the operation is performed better, and the flax is injured less, by having the arms holding the blades made so as to spring a little when the blade strikes against the flax.

A scutch-mill such as has been described (Plate III) will cost in Great Britain from £10 to £12 15*s*. per berth, according to the number of berths. The former price is for 20 to 30 berths, the latter for 5 to 10 berths. The prices include line of shafting, fitted on columns with brass bearings, wiper-rings, fireproof iron berths, &c. The prices for hemp-scutching mills, of the same kind but stronger, are about ten per cent. higher than those for flax.

In Ireland, the proportion of scutch-mills in 1860 was one mill to every one hundred and thirty-three acres of flax grown; while the proportion of stocks or "berths" was one to every twenty-five acres.

Figure 13 represents a scutching-machine now much in use in Great Britain. In this machine the scutching is effected by means of a revolving drum, placed in a cast-iron frame, covered with sheet-iron. Round the periphery of this drum, and parallel to its axis, are fixed tough, flexible, wood blades, the leading edges of which are sharpened. At the back of each blade is placed a row of semi-circular metal scrapers resembling finger-nails, and immediately behind them a projecting metal blade. In front of the machine, as will be seen on the left-hand side of the illustration, are two iron face-boards, pivoted at their base, and adjustable by means of screws and lock-nuts, so as to allow of their being set nearer or further from the revolving blades. To the inside of these face-boards are fixed sheet-iron curved spring-plates, also adjustable by nuts and screws. At each side of the machine there is an opening in the cast-iron frame to allow the flax straw to enter.

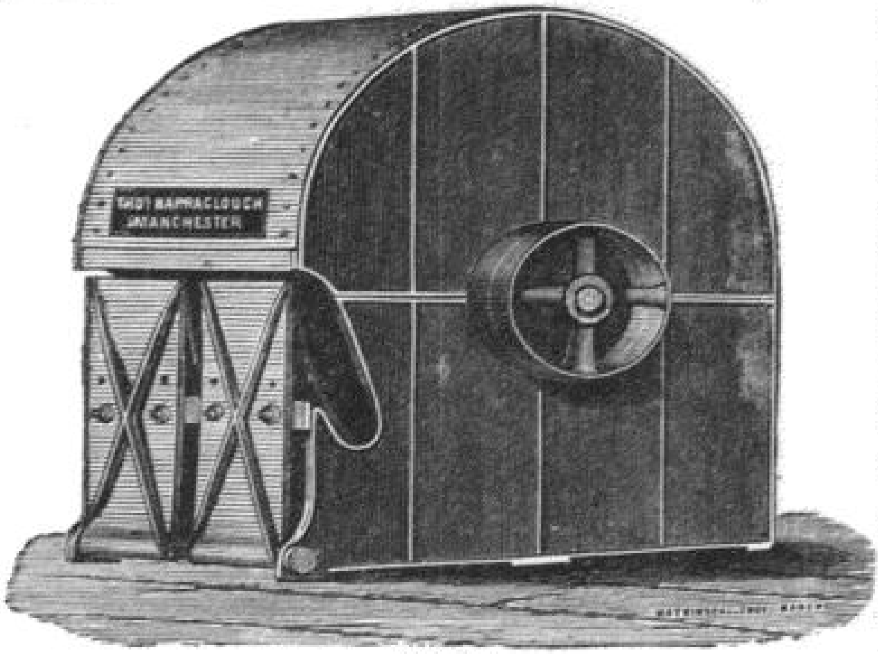


Fig 13.

The operation of scutching is as follows: The workman takes a streak of the broken straw, and standing in front of one of the face-boards or "stocks," inserts one end of the straw through the opening at the side, retains the other end in his hands, resting it upon the top of the stock. The revolving blades then begin to strike it in the direction of its length. The metal scrapers, mentioned above, serve to bring new fibres under the action of the blades. These scrapers imitate the action of the workmen, who, when scutching by hand, run their fingers through the fibres in order to increase the effect of scutching by exposing different portions to the action of the blade. The workman gradually slides the straw towards the centre of the machine, and withdraws it through the open space between the two stocks. He then inserts the other end of the straw through the side opening. Having thus rough-scutched the handful, he hands it to the man at the other stock, who treats it in the same manner. In this side the stock is set nearer to the revolving blades, so that the flax is finished. Each machine is, therefore, attended by two workmen—a "buffer" and a "finisher."

These machines are usually placed in a row side by side. Instead of a wiper-shaft as shown in the scutch-mill, Plate II, the shaft in the breaker-room is prolonged the whole length of the building, and carried by brackets in the wall. On this shaft are placed the pulleys which drive the scutching-machines.

The scutching-room, as shown in the plan, will hold ten scutching-machines, giving employment to twenty workmen. At the back of the machines is placed a flue connected with each machine, and with a fan or blower, which draws off the dust, wood-boon, tow, &c., from the machines, and delivers them outside of the building. In this way the scutching-room is kept free from dust and dirt. The above machine (Fig. 13) will cost, laid down in New York, freight and duties included, about $200. A hemp scutching-machine of the same kind, but with larger drum, will cost, at same place, about $300.

Figure 14 represents a power scutcher used in the scutch-mills in this country. It consists of a system of scutching-knives of hard wood, set around a shaft like the spokes of a wheel, as shown in the illustration. The flax-straw is held through the slot in the upright board, in the same manner as in hand-scutching. The shafts revolve at the rate of from 150 to 200 revolutions per minute. The knives are placed close to the scutching-board, so that they may strike the flax. The shaft can be made any desired length, with a set of knives placed every three or four feet.* Breaking and scutching flax is becoming more of a manufacturing operation. In the flax-growing districts of New York and Canada, scutch-mills are operated in every neighborhood. The flax-grower often sells the flax in the straw to the mills. Sometimes the mills purchase the straw with the seed on, and relieve the grower of

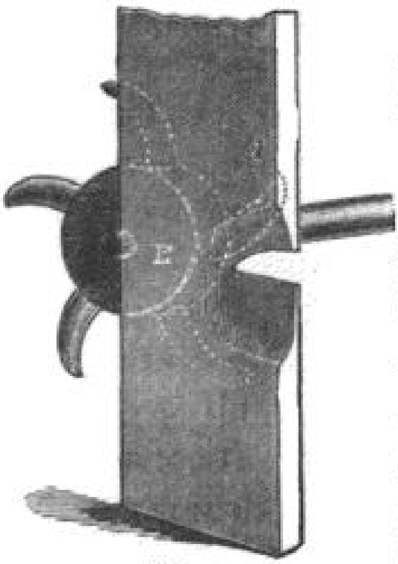


Fig. 14.

* Scutching-machines, such as Figure 14, are manufactured by the makers of the Mallory & Sandford brake, in New York.

all of the operations of rippling, retting, and scutching. Where this is done, no crop will bring a quicker return than flax, as only a few weeks are required to bring it to maturity after the seed is planted. When properly managed, a profit can be made in each of the above operations, and there is no reason why the grower should not have the benefit of these profits. It is desirable that manufacturing upon the farm be carried on: besides, if the straw is sold before retting, the fertilizing elements extracted from the soil will be removed from the farm, and a decrease in fertility result.

A system of machinery has been invented for taking the tangled flax (grown for seed in the West, and cut with a machine), straightening, breaking, and scutching it. Such a system is now operated at Muncie, Indiana, with very good success. The fibre produced, however, is only used in the coarser kinds of manufactured articles, such as twine, bagging, &c.

There are machines for removing the dust and shives from the tow made in scutching. When flax has been properly retted, such tow can be cleaned, and sold at a profitable price.

Various machines have been invented for the purpose of brushing the flax and hemp after scutching. The effect of brushing is to free the fibres from dust and all extraneous matters and to brighten the fibre. Figure 15 is an illustration of one of these machines. It consists of an iron drum, revolving at a high speed, between two iron frames, the whole being cased in with sheet-iron; round

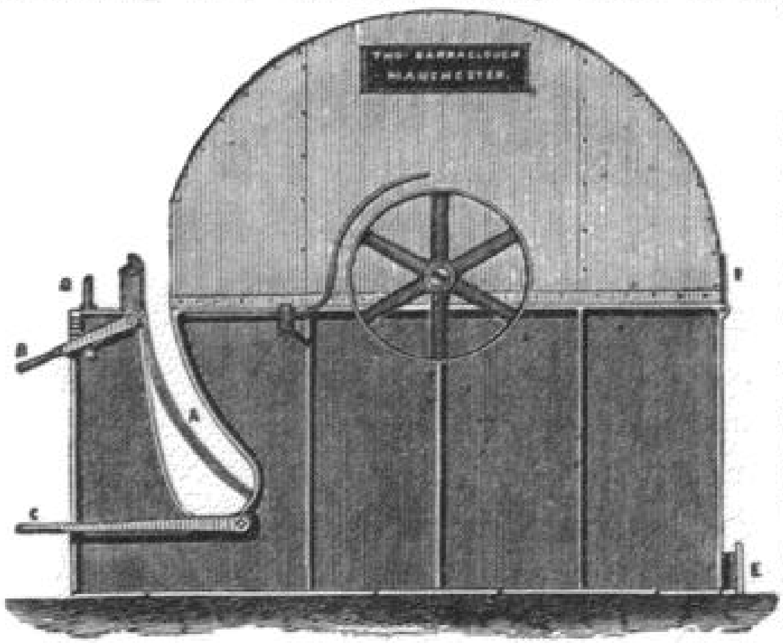


Fig. 15.

this drum a series of "kittool"* brushes, with wood stocks three inches wide and eighteen inches long, is fixed in a suitable manner. At each side of the framing there is an opening for the admission of the fibre. Inside the casing is a curved wooden shield, *A*, which, by means of the lever *B* and the treadle *C*, is brought nearer to, or removed further from, the periphery of the brushing-drum. The lever *B* actuates the upper end, whilst the treadle *C* acts on the lower end of the shield. Its position can thus be regulated according to the class of work that is being done. After the flax has been introduced in the opening in the side, the operator twists one end around the pin *D*, and by means of the lever *B* and treadle *C*, exposes all parts of the flax to the action of the brushes.

Inside the machine is a small fan, which collects the dust and fine tow, and drives it out through the opening *E*. At *E* there is a small door or shutter opening outwards; on the inside of this is fixed a comb, which, when the shutter is closed, comes in contact with the brushes, and thus cleans them from the tow or shives which may adhere to them.

The flax-fibre is now ready for the manufacturer, and the price which the grower will realize will depend on the care he has bestowed upon the flax in the culture and after treatment. If he has given proper care, he will be well repaid for all the labor bestowed upon it. We earnestly urge the agriculturalists of Kentucky to add flax to their regular rotation of crops. We are deficient in the number of crops grown in this State, having only four or five in rotation, even where any attempt is made at regular rotation. Of course, flax can only occupy a small percentage of the regular crops grown. In Belgium, in addition to the regular cereals and grasses, the following enter into the regular rotation: turnips, sugar beet, colza, flax, potatoes, tobacco, &c. The oil-cake made from the various oleagenous plants grown in Belgium plays an important part in Flemish agriculture. Such plants also draw a large

* *Caryota Urens* (kittul or kittool), a species of palm common in India and Ceylon. The black, wire-like fibre is from the leaf-stalks. It is extensively used in machine brushes, for polishing linen and cotton yarns, for brushing cotton velvets, and other similar purposes.

supply of nourishment from the atmosphere. Thus Belgium is enriched; an almost barren soil has been brought to a marvelous condition of fertility, supporting a population of 461 to the square mile. Whilst we see here, in our comparatively new country, population continually shifting on account of exhaustion of soil, the last census of Belgium shows an immigration of 15,792, and an emigration of 7,981; whilst the agricultural reports of that country show that the yield of the land is continually on the increase.* If we are to preserve this beautiful Kentucky for future generations, a change in the system of agriculture must be adopted. There can be but one result from a long-continued exportation of grain and tobacco: impoverishment and abandonment. By increasing the variety of crops grown, and producing material requiring manufacture, the idle water-powers of the State can be put at work, and the increased population requisite to manufacture the products will consume among us the produce grown upon the land. Besides, the farmer can thus give steady employment during the

* Of a total of 7,374 emigrants leaving the port of Antwerp for the year 1876, only 200 were native Belgians. The majority were Germans, Austrians, and Russians. It is well known that there is little emigration from the rural districts of France, and that France suffered little from the recent financial troubles, so disastrous in Europe and America. The cause of this exemption from the wide-spread financial "panic," and the wonderful recuperative powers exhibited by the French nation, after the ravages of the Franco-German war, and the large money indemnity exacted by Germany, has been the theme of much speculation. A study of the following facts may offer some solution to this problem: Since the abolition of the Feudal system in France, lands have been divided equally among the children upon the death of the parent; and thus estates have been divided and sub-divided; the number of land-owners steadily increasing, until there is a large population of farmers in France owning only a few acres of land each. It is evident that these small land-owners could not afford to purchase and use the labor-saving machines so universally in use by the agriculturists in England and the United States. The French farmer finds it more profitable to cut his few acres of grain by the old hand-process, and thresh it out on the barn-floor by the old-fashioned "flail," than to purchase and use expensive machines for these purposes; and so with other crops, many of them being of such limited area that the interest on the cost of the machines, and cost of working, would hire the labor necessary to cut and thresh the grain. Thus constant employment is given to a large rural population. They are productive *consumers*, whilst our machine-threshers are productive *non*-consumers; consequently our grain must be exported. Allied to, and growing out of, this condition of affairs, extensive domestic manufacturing is carried on, and nearly all of the returns from agriculture and manufacture is distributed among the people, so that in France the percentage of persons who spend more than they earn is much less than in England or America. These and other causes have so "fixed" the population that on their little farms and small homes the small surplus earnings of generations have been expended, so that a French farmer, with but a few acres of land, and an income which would appear contemptible to an American farmer, has an inherited accumulation of the comforts of life much greater than a migratory agriculturist in this country who can count his acres by the hundreds. In France, the national loan was taken by "the people," from their surplus earnings, and as the interest is paid to the people, the burdens are light. In England and America, the national loans were taken by the capitalists, and the interest is paid, by the people, to the capitalists.

entire year to a larger amount of labor, giving an additional profit to the agriculturist, and relieving the overcrowded towns of an idle population. For every idle consumer, some one must do extra work, generally without extra pay; and I believe that it can be demonstrated that this extra work, without just compensation, finally comes off of the agriculturist. To the agriculturist, therefore, it is pre-eminently important that the idlers be put to work; and I have attempted to show that in the culture of flax the farmer can do much towards the accomplishment of these desired ends.

HEMP CULTURE.

Hemp, the *Cannabis Sativa** of botanists, is supposed to be a native of India or some other Eastern countries. It has been cultivated in Bengal from the remotest antiquity, but its Greek and Latin name, *Cannabis*, is derived from the Arabic *Kinnub*. (Sans., *Bhanga, Ganjica;* Hind., *Ganja;* Arab., *Kinnub;* Pers., *Bung;* Ger., *Hauf;* Dan., *Kanip* or *Kinnep;* Swe., *Hampa;* Du., *Hennip;* Fr., *Chanvre;* It., *Canape;* Rus.,

*The following description of the hemp-plant is from J. Forbes Royle's "Manual of Materia Medica:" "The hemp is a diœcious (occasionally monœcious) annual, from three to ten feet high, according to soil and climate; root white; fusiform; furnished with fibres; the stem erect; when crowded, simple, but when growing apart, branched even from the bottom, angular, and, like the whole plant, covered with fine, but rough, pubescence; the stem is hollow within, or only filled with a soft pith. This pith is surrounded by a tender, brittle substance, consisting chiefly of cellular texture, with some woody fibres, which are called the *reed, boon,* and *shove* of the hemp. Over this we have a thin bark, composed of fibres, extending in a parallel direction all along the stalk. These fibres consist of delicate febrils, united together by cellular tissue, and all covered by a thin membrane or cuticle. The leaves are opposite or alternate, on long petioles, scabrous, digitate, composed of from five to seven narrow, lanceolate, sharply serrated leaflets, of which the lower are the smallest, all tapering at the apex into a long entire point. Stipules subulates. *Males* on a separate plant. Flowers in drooping, axillary, or racemose panicles, with subulate bracts. Perianth, 5-parted; segments not quite equal, downy. Stamens, 5; filaments short; authers large, pendulous, 2-celled; cells united by their backs, opening by a longitudinal slit. *Females* in a crowded, spike-like raceme, with leafy bracts. The perianth consists of a single, small, spathe-like sepal, which is persistent, accuminate, ventricose at the base, embraces the ovary, and is covered with short, brownish glands. Ovary sub-globular, 1-celled, with one pendulous ovule. Style short. stigmas 2, elongated, grandular. Nut ovate, greyish-colored, smooth, covered by the calycine sepal, bivalved, but not dehiscing, and inclosing a single oily seed; seed pendulous. Testa thin, membranous, marked at the apex with a colored hilum. Embryo without albumen, doubled upon itself. Radicle elongated, turned towards the hilum, and the apex of the nut separated from the incumbent plano-convex cotyledons by a small quantity of albumen."

The male is quicker in growth than the female, and generally grows half a foot or more higher, by which provision of nature the pollen from the stamina, or the fecundating dust which conveys fertility to the seed, is readily shed on the lower plant.

Konopel; Pol., *Konope;* Erse., *Canail;* Lat., *Cannabis;* Anglo-Saxon, *Haenep.*)

In the East it has hitherto been cultivated mainly on account of its exhilarating and intoxicating properties. Among the Arabs it is known as "the increaser of pleasure," and "the cementer of friendship," &c. In India, the name of the narcotic produced from hemp is *bhang*. The bhang is an efflorescence of resinous matter occurring on the capsules and leaves of the plant. It is said that the Indians will sometimes run through the growing hemp, after which this matter is scraped off of the clothing, and a decoction made.

The "*hashish*" or "*hasheech*" of the Arabs is similar to the Indian bhang.*

In Europe and America hemp is grown for its seed and for its ligneous fibre, and we will here treat of it as a fibre-producing plant.

Kentucky is, and has long been, the principal hemp-producing State in the Union. Of 11,746 tons produced in the United States in 1870, Kentucky produced 7,777 tons, or more than one half. Nearly all of the hemp produced in Kentucky is in a few counties of what is known as the "Blue-Grass" Region. In those counties, so long has hemp-culture been carried on, that a good knowledge of the best methods of culture is almost universal among the farmers, and a treatise on hemp-culture would seem almost superfluous; but there are reasons why the area of hemp-culture should be extended in Kentucky. Other portions of the State may not produce so large a yield, but the fibre may be finer, and bring a higher price in the market, or the relative profit received from a crop of hemp may be as great or greater than from other crops grown on the same land.

* Bhang is also known in India as *gunga, churrus, or charas*. Gunga is the flowering or fruit-bearing tops of the plants. Churrus is the resinous exudation which coats them. The effects of this drug on the population of India are as follows: "It alleviates pain, and causes a remarkable increase of appetite, unequivocal aphrodisia, and great mental cheerfulness. Its violent effects are delirium of a peculiar kind, and the production of a cataleptic condition. Sir Robert Christison says that 'for energy, certainty, and convenience, Indian hemp is the next anodyne, hypnotic, and antispasmodic to opium and its derivatives, and often equal to it.' Preparations are used in the British Pharmacy in the form of tincture and extract prepared from gunga, and it is understood to form an ingredient in the patent medicine chlorodyne."

The increasing demands for hemp of finer fibre for spinning will probably introduce the practice of water-retting. Hemp will then bring a quick return, as it can be made ready for the market by the latter part of August or early in September, according to the season. Spinning hemp on jute and flax machinery began in this country but a few years since, but it has already grown to considerable proportions. The investigations of the microscope demonstrate that the ultimate fibres of hemp are nearly as fine as those of flax. The difference is, that the flax is more readily divisible. Improved methods of retting the hemp, and softening, which is simply a removal of the cementing gluten by mechanical means, render the hemp sufficiently fine to take the place of the coarser kinds of flax. Under the old hand-processes of manufacturing, hemp was used in this country and in Europe in the manufacture of coarser linens, threads, &c. It was thought that the linens made from hemp bleached more easily than flax linen, and always improved in color by wearing. Spinning machinery was first adapted to the flax-fibre; consequently, hemp was only used in coarse articles, such as cordage, bagging, twines, &c. Gradually machinery in Europe has been made stronger and more suitable to the spinning of hemp, and in France, Italy, Bavaria, and other European countries, the spinning of hemp on machinery has made rapid progress. At the International Exhibition in Philadelphia, in 1876, strong sewing-thread of hemp was exhibited from France, fabrics of hemp and machine-spun thread of great excellence from Spain, and hempen thread from Portugal. No country can grow finer hemp than Kentucky, and the indications are that the demand for Kentucky hemp will steadily increase until it is as great as in past years; but the demand will require hemp more carefully prepared. Formerly it was for cordage and bagging. In the future, in addition to the requirements for those articles, there will be a large and increasing demand for spinning into yarns of coarser number, for finer twines, and, I believe, for crash and towelings. The agriculturist who anticipates this demand by growing the finer qualities of hemp, and prepares to water-ret it, will command a remunerative price for his product.

At present Italian hemp is selling in New York at $270 per ton, and Kentucky hemp at $130 per ton. I am convinced that, grown with the same care and water retted, the Kentucky hemp is in every respect equal to, and very like, the Italian. Surely here is a way by which a large increase in value may be added to our agricultural products.

The methods of hemp-culture are so well known in Kentucky that it is not so important to particularize as in describing the culture of flax; but I will give in brief the most approved methods abroad.

The land should be prepared carefully, as for flax. If sod-land is to be put in hemp, it should be ploughed the preceding autumn, so that the soil may be pulverized by the frosts; the young hemp will also suffer less from cut-worms. The seed should be of a bright grey color, and well filled, and must not have undergone heating in any way. The quantity sown must vary according to the quality of the land, and the object for which the hemp is grown. The usual quantity in Kentucky is one bushel to the acre. This is much less than is recommended by the writers on this subject in Europe, from two to three being given. There is nothing gained by sowing more than enough seed, as the hemp, if too thick, will thin itself by smothering out the smaller plants, and this must be done at a loss of vitality. When the hemp is to be grown for cordage, a smaller quantity of seed drilled in will answer. I have seen a fine yield of hemp in Kentucky from three pecks of seed planted with a grain-drill. Early sowing is recommended; but when prevented by the weather, hemp may be sown in Kentucky as late as June 1st. After sowing the seed, harrow and cross-harrow, and roll the land. The hemp ripens enough for harvesting in from eleven to thirteen weeks. The male hemp ripens sooner than the female; and in Europe the hemp is often planted in beds with paths between, so that the male and female stalks can be pulled separately.

No hemp is pulled in this country, nor do I think there is any advantage in this method to compensate for the extra labor and cost over cutting. Hemp is cut in Kentucky when the leaves turn yellow, and begin to drop from the male plant. The female plant is then green; but hemp-growers have found, by experience, that if the hemp is not cut until the female hemp has changed color, there is a waste of fibre in the male hemp, without a compensating gain in the yield and quality from the ripened female plant.

In Italy and some other European countries hemp is pulled; but the experience in this country is opposed to this method, and all hemp is cut. Formerly a bent hook was used; but this has given place to a blade about eighteen inches long, slightly curved, with a handle placed at right angles to the blade. The workman gathers in his left arm the hemp, and drawing the hook along the ground, cuts the hemp off close to the ground. An average workman will cut about one half an acre of hemp a day by this method. Machines are manufactured for cutting the hemp, and when the stalks are very fine, they can be cut with a grass-mowing machine.

The hemp is spread in rows upon the ground, the butt-ends even. Some of the hemp-cutters acquire great skill in throwing the hemp, after cutting, so that it will fall in even, smooth rows. The hemp is allowed to lie in rows to dry, which will require a week or less, according to the weather. If the hemp is to be water-retted, the drying is unnecessary, and some authorities think that better results are obtained when the hemp is retted immediately after harvesting. It is said that hemp steeped green will require only four days, but if allowed to dry, eight days will be required to steep it in water. Sometimes, when hemp is cut late, it is not bound up after spreading, but put up in "shocks," kept standing by tying bands around each. These remain until time for spreading. The best method is to bind the hemp into sheaves after it has been cured, and place it in round stacks or ricks until the proper time for spreading. The stacks are enlarged from the bottom up half-way, and then drawn in up to a point and thatched with long stalks, freed from leaves by beating, the thatch projecting so as to protect the butt-ends of the bundles from the rain. Ricks are built 30 to 40 feet long, the length of two bundles wide, and thatched with the hemp-stalks in the same way as the stacks. Less of the hemp is exposed to the weather when in ricks than in round stacks; but the farmers in Central Kentucky prefer the latter plan. The fibre of the hemp used in thatching is damaged, and should be kept separated from the good hemp after it is broken.

The best time for spreading hemp is in November or December; but it is well to begin spreading sooner if the grower has a large crop to handle, so that he may commence breaking earlier. Winter-retted hemp is generally of a brighter color than hemp spread in October. The hemp is usually stacked and spread on the same ground on which it is grown. When the hemp is sufficiently retted (which can be determined by breaking out some of it, or an experienced hemp-grower will know by the appearance of the stalks), it is taken up and put in shocks. If the hemp be dry, the shocks should be tied around the top, with a band of the hemp, as tightly as possible, to prevent the rain from wetting the inside. To make the shocks firm, so as to guard against being blown down by the wind, it is necessary to tie with a band the first armful or two, and by raising it up and beating it well against the ground, cause it to stand firmly. The remainder of the hemp is set up around this central support, and by flaring the bottom, and tying well, a firm shock can be made. In Kentucky, all of the hemp is broken by the long-used slat hand-brake. These are moved around the field so as to avoid carrying the hemp-straw. The usual task on one of these hand-brakes is 100 pounds a day of clean fibre; but much more can be broken by a good worker: 200 pounds is not an unusual average for a good hemp-breaker. Each "hand" of hemp, when cleaned, is twisted in the middle, and these are made into bundles of about 100 pounds each.

The process of water-retting hemp is the same as practiced for flax, and the directions given on page 124 to page 142 will answer equally well for hemp. Some years ago, Henry Clay, who was a practical hemp-grower, introduced water-retting, and induced some farmers to make a trial. They were successful in producing a strong, soft fibre, but at that time the only demand for hemp was for cordage, ship-rigging, bale-rope, and bagging. Dew-retted hemp answered equally well for bale-rope and bagging as the water-retted; and for ship-rigging it came in competition with the bright snow and water-retted hemp of Russia, so that the price would not justify the extra expense of water-retting, and the practice was abandoned.

Now that hemp is so in demand for spinning into yarns, carpet-warps, &c., and for fine twines, a carefully water-retted hemp will come in competition with the fine Italian hemp, and I believe a remunerative price can be obtained by the grower for such hemp. In this connection I desire to call attention to what was known as the Barlow process, patented by Milton Barlow, of Kentucky, about forty years ago, and prior to the Schenk, Watt, and other similar processes. In 1839 and 1840, Mr. Milton Barlow and his son, M. Barlow, jr., experimented in the process of retting hemp, and in 1843 they associated with them Mr. Jas. Weir, and built an establishment for retting, breaking, and preparing hemp for the United States Navy. The establishment prospered until the purchase of hemp was suspended by the agent of the Navy, and the only partner having money removed to another State to look after a large landed interest.

By this process the hemp is steeped in warm water, at a temperature of 85 to 90° Fahrenheit, until it is well macerated or retted. Then the temperature is raised to the boiling point, which, it was claimed, stopped the maceration, and made the fibre susceptible of standing years of exposure. The establishment consisted of four vats, each ten feet wide, forty feet long, and five feet deep, built of oak plank, similar to tanner's vats; into these ran steam-pipes, by which the water was heated. The steeping process required about 6c hours. After the hemp was taken from the tanks, it was set up in shocks, of eight or ten bundles each, to dry, after which it was broken on a roller-brake. The principal defect seems to be the time required, as it was necessary to draw off the water from the tanks, and wait for the hemp to cool before it could be removed. By providing heavy crates and a traveling crane with pulleys, the hemp can be lifted out as soon as retted, and a crate with unretted hemp immediately placed in the vat. In this way the cost of handling and time required will be diminished. I am convinced, from investigations made concerning this process, that it merits a careful trial, and that great results may be hoped for from experiments conducted intelligently. The hemp produced was of superior quality, and would now probably be greatly in demand as a substitute for Italian hemp.

The steep-water from this steam process is not offensive, as is the water from water-retted hemp.

Good hemp land in Kentucky will produce 1,000 pounds of clean fibre per acre. The cost of cultivating and preparing for market varies in various localities, and is governed by the condition of the land and state of weather, so that it is difficult to make an estimate. I give herewith estimates, by careful hemp-growers, from the counties of Fayette (1), Woodford (2), and Franklin (3), based on a yield of 1,000 pounds of fibre per acre:

	(No. 1.)	(No. 2.)	(No. 3)
Ploughing 1 acre	$2 00*	$2 00*	$1 00
Harrowing	25	25	20
One bushel of seed	3 00	3 00	3 00
Sowing seed and harrowing in	50	45	40
Rolling	12	10	10
Cutting hemp	2 50	3 00	3 00
Binding and shocking	1 00	2 00	1 00
Hauling and spreading	1 00	1 50	1 00
Taking up and stacking	40	50	50
Breaking	8 00	10 00	10 00
	$18 77	$19 80	$20 20
Rent on land	10 00	10 00	10 00
	$28 77	$29 80	$30 20

* Estimates for ploughing sod-land and stubble.

It will be seen that these estimates, although made without concurrence between the persons making them, agree very nearly as to the cost of growing hemp. The average of the three estimates is $19 59 per acre, or, adding rent of land, $29 59. If the farmer will grow 1,000 pounds or more per acre, he can be assured of a good profit from hemp culture. The largest item is for breaking the hemp. The farmer who could give steady employment throughout the year to the number of workmen necessary to break out his hemp could reduce this item one half; for, under the present system, the cutting and breaking of the hemp is done in a great measure by negroes living in the towns, who go to the country and earn large wages during the hemp season, and then return to the towns and consume their earnings.

The many attempts to introduce power-brakes for hemp have failed, and the Kentucky hemp-growers now believe that it is impossible to substitute the old hand-brake.

The manufacturers of the Mallory & Sandford flax-brake have manufactured a roller-brake for hemp, which they believe will do the work in a satisfactory manner. I hope this brake will be tested in the hemp-growing district of Kentucky by the time of the publication of this report; also the machine referred to on page 149.

A system of machiney for treating both unsteeped and steeped hemp has recently been invented and put into operation in Galicia. I am informed that this system is in successful operation also in Hungary and portions of Russia. It is claimed by the inventor of this system, in a letter recently received, that the working capacity, in treating unsteeped hemp-stalks, in an air-cured condition, and without any other preparation, is from 30,000 to 40,000 kilogrammes per 12 working hours. This quantity of stalks will yield about 15 to 20 per cent., or from 4,500 to 6,000 kilogrammes of clean hemp fibre. With the highest working pressure, from 6,000 to 8,000 kilogrammes might be attained.

From forty to fifty hands are required for the service of such a system; and it is claimed that the work of sorting the hemp and serving the machines is so light that most of it can be performed by children. About twenty-five-horse power is required to operate a complete series.

The machines will also work hemp-stalks that have been retted, more easily, and produce a larger percentage of clean fibre. The machines, whilst separating the shives, at the same time *soften* the hemp, thus preparing it for the spinning of finer yarns.

I have samples of both unretted and retted hemp fibre prepared by this system, and it is clean, soft, and fine. Arrangements have been made to have the working of this system examined by an able expert in the manufacture of hemp, and the results of his examinations will be given to the hemp-growers of Kentucky.

It is to be hoped that the agriculturists of Kentucky will organize a Society for the Promotion of the Hemp and Flax Industry. In this way the most advanced knowledge of approved methods of culture and after-treatment can be disseminated, and a stimulus given to the culture and manufacture of these important fibres.

INDEX.

(THE NUMBERS REFER TO THOSE AT THE TOP OF THE PAGES.)