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A. C. TRUE, Director.

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THE EVOLUTION OF REAPING MACHINES.

BY

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LETTER OF TRANSMITTAL

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS,
Washington, D. C., January 1, 1902.

SIR: I have the honor to transmit herewith, and to recommend for publication as a bulletin of this Office, an article on the evolution of reaping machines, prepared under the general supervision of Thomas F. Hunt, dean and professor of agriculture, College of Agriculture and Domestic Science, Ohio State University, by M. F. Miller, when a candidate for the degree of bachelor of science in that college. The article summarizes the history of the various stages in the development of reaping machines in so satisfactory a manner that it is deemed worthy of publication by the Department as a useful contribution to information on the important subject of farm machinery. It has not been attempted in this summary to refer to all inventions in connection with reaping machines, but, as a rule, only those are considered which have marked some important advance in the development of the perfected modern machine. A few of the more important sources of information drawn upon in the preparation of the article are referred to in footnotes; a more complete list of authorities consulted will be found at the end of the bulletin (p. 42).

Respectfully,

A. C. TRUE,
Director.

Hon. JAMES WILSON,
Secretary of Agriculture.

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THE EVOLUTION OF REAPING MACHINES.

HAND REAPERS.

Agricultural machinery is a most important factor in the world's progress, and one which has shown a marked development in recent years. In no class of agricultural implements has there been a more marked development than in that for reaping grain. This development has taken centuries, not because of such a great number of stages, but because of the time in which development was almost wholly wanting—a time extending through centuries when the sickle reigned supreme.

The process of reaping is older than written history. Among the remains of the later stone period in Great Britain and on the Continent are found implements of flint resembling a rude form of sickle or reaping hook, while bronze sickles occur quite frequently among the remains of the early European inhabitants. Our earliest records give accounts of reaping, which was in most cases carried on by means of implements resembling our modern sickle in form, but of crude construction. These earliest records are from Egyptian history. In that favored land, watered and fertilized by the river Nile, we see the early stages of agricultural development. Here grain was sown, trampled into the loose ground by the hoofs of animals, and left to grow from the rich soil where so little care was needed to produce a crop. It is among the early works of this remarkable people that we find the first records of the process called reaping. A tomb at Thebes, probably built 1400 or 1500 B. C., bears a painting which shows the various operations connected with the cultivation and harvesting of grain. After the style of these ancient works of art, the different operations are shown in series in the same painting. Two men are represented with sickle-like implements, cutting the grain somewhat below the heads. They stand side by side and appear to be making the movements simultaneously; behind them a third man, working alone, seems to be gleaning, while others carry the grain to the oxen, which are tramping it out. Other paintings of this time show two distinct modes of reaping. One was to cut low, a handful at a time, and bind into sheaves; the other, which may scarcely be termed reaping, consisted in pulling up the plants by the roots, the heads afterwards being stripped from the stalks by means of a comb or hackle.

These ancient Egyptian sickles varied somewhat in form and material. The earliest form consisted of a slightly curved blade fastened at one end to a straight handle (fig. 1, *a*), both iron and bronze being used. Later the toothed sickle appeared (fig. 1, *d*), the form approaching more nearly that of the modern sickle.

The ancient Chinese and Japanese used an implement resembling the sickle, and almost the same thing is used by them to-day. The Japanese used also another implement for reaping, which they called "ani-ani." This cut on the principle of scissors, but was inferior to the reaping hook and was abandoned. It is a remarkable fact that these two large and ancient nations still cling to the reaping hook in harvesting their grain.

The implements of the Jewish people resembled closely those of the

FIG. 1.—Different forms of sickles and scythes: *a*, Egyptian sickle; *b*, sickle of the middle ages; *c*, later smooth-edged sickle; *d*, later toothed sickle; *e*, early form of scythe; *f*, Hainault scythe and hook.

Egyptians. The sickle was very common, and this, together with the reaping process, is frequently mentioned in the Bible, for instance: "They reap every one his corn in the field," Job 24: 6; and again in Revelation 14: 15, we find "Thrust in thy sickle, and reap."

To Greece the art of agriculture was passed down from the Egyptians. The Romans, too, aided in the development, and considerable advancement was made in the form of implements during Greek and Roman times. Varro describes three modes of cutting the straw as common in Italy. The first was to cut low with a reaping hook a handful at a time; the second, to cut below the heads with a sickle,

consisting of a curved stick with a toothed blade attached, and the third, to cut at the middle of the straw.

The manner of gathering differed likewise, the grain sometimes being bound into sheaves, or, when the heads alone were detached, they were either taken directly to the threshing floor or placed in store-rooms. Among Roman implements we find besides the ordinary form of sickle and reaping hook a small hooked knife resembling a pruning knife, which was used for reaping. It is at this time also that we find the first records of the scythe being used, and although it is not known exactly when it first appeared, the Romans certainly used it, as ancient Roman drawings show. It was crude in form, consisting of a heavy blade on a long straight handle, and was used more for grass than for grain, the sickle remaining preeminently the reaping implement. Pliny distinguished between the sickle and the scythe, although both were at that time called "sickles." The shorter one, which resembled the modern form, he termed the Italian sickle, and the longer one with two handles or hand holds, which corresponded to our present scythe, he called the Gallic sickle.

After Roman times agriculture began to decline and continued at a very low state for about ten centuries, or almost throughout the Middle Ages. The pasturing of cattle and sheep in such times of strife and trouble was, of course, preferred to tillage, because animals might be concealed or moved; but few will sow without a reasonable degree of certainty of being able to reap. Some of the operations of tillage were not forgotten, as they were retained by the priests and monks. After about ten centuries agriculture began to revive, and with it was brought back the extensive use of the sickle and scythe.

Crescenzio in 1548 gives an account of the implements then in use, and among them we find forms of the sickle and scythe as shown by drawings. From this time on, both are found in very general use throughout different countries, and both have remained as useful implements up to the present time.

It would be impracticable, if not impossible, to trace in detail the various changes of form which these implements have undergone in the development since the earliest times, but some of the more important types should be mentioned.

As already stated, the early Egyptian sickle consisted of a slightly curved blade of iron or bronze, attached to a straight handle, while the toothed form of the implement was a later Egyptian type. Soon a greater bow was given the blade, and it began to look more like the modern form. The smooth sickles were heavier than the serrated forms, and were generally used for cutting near the ground with a chopping motion. The toothed sickle was used to cut the grain nearer the top by means of a drawing motion. As time went on the blade was strengthened by an iron ridge near the back, and finally a steel

edge was used. With these improvements both the smooth and serrated sickles reached their most perfect form.

The scythe was a later implement than the sickle, and was an evolution from it. It forms what might be termed the second class of reaping appliances, the sickle being first and the horse reaper last. As has been stated, this second class made its appearance about the time of the Roman era. The first forms had straight handles and were very clumsy and heavy, being used only for cutting grass. A Flemish implement known as the Hainault scythe was a form intermediate between the sickle and scythe, and was used for cutting grain. It consisted of a wide blade about 2 feet in length, with a handle a little over half as long. It was held in the right hand with the forefinger in a leather loop, the blade being kept in a horizontal position by a flat, projecting part of the handle against the wrist. (See fig. 1, *f*.) The grain was gathered by a hook held in the left hand. This was much more efficient than the sickle, but was surpassed by the later forms of the cradle scythe.

The forms of the scythe varied greatly, particularly in the handle. The blade became lighter as time went on, and the handle passed through various double, forked, and iron forms, to the final crooked wooden pattern. But with this development, a new feature appeared, which transformed the scythe into a practical hand reaper. This was the fastening of fingers to the snath to assist in collecting the grain into bunches or gavels. Among the earliest devices of this kind was one which consisted simply of "two twigs of osier put semicircularly into the holes made in the snath, near the blade, in such a manner that one semicircle intersected the other." This, projecting upward on the snath, helped to carry the grain around the scythe so as to leave it in a bunch. About the same time fingers were introduced—first a single pin inserted in a hole in the snath, later a series of three or four short fingers on a bar which was fastened to the snath in such a way that the fingers extended on a line with the scythe. This form generally had a double snath and a blade much longer than the fingers (Pl. I, fig. 1). In using it the operator cut toward the grain, leaving the cut stalks standing in a fairly well-gathered bunch against the standing grain.

With the development of agriculture among the American colonists came an improved form of the cradle scythe (Pl. I, fig. 2). Doubtless all the European types had been brought over by the colonists, and what is termed the "American cradle" was simply an improvement upon some of these earlier forms. It is impossible to determine just when this implement was invented, but this is of little consequence, as it was doubtless a growth rather than a single invention. It is known to have been in quite common use before the beginning of the nineteenth century, and was rapidly taking the place of the sickle. Professor Brewer, of Yale, in his history of agriculture in the

FIG. 1.—EARLY CRADLE SCYTHE.

FIG. 2.—AMERICAN CRADLE SCYTHE.

FIG. 3.—THE GALLIC HEADER, DESCRIBED BY PLINY A. D. 70.

United States, written for the Census Report of 1880, divides the history into four periods, the second of which extends from the time of the Declaration of Independence to the introduction of the cast-iron plow about fifty years later. Of this period he says:

Many other improved implements came into use during this same fifty years, of which the two most important in connection with American grain growing were the American cradle and the fanning mill for cleaning seed after it was thrashed. The sickle was common, though not in universal use at the time of the American Revolution. It was rarely used when the century closed and had ceased entirely as an implement for cutting other cereals than Indian corn before the close of this period.

These statements fix the introduction of the American cradle as somewhere between 1776 and the close of the century.

The American cradle was the culmination of the improvements in hand-reaping implements which had begun ages before in the rude stone implements of prehistoric races. Why it should have taken so many centuries to reach its perfect form is a subject for conjecture. Once perfected, it spread rapidly to other countries either in its original form or in a form modified by foreign manufacturers. To-day it is still used in various parts of Europe, and even in America where conditions make the use of the reaping machine impracticable.

The sickle still has its place even in the most advanced nations, and it is used almost exclusively in some of the least developed countries, especially in the Orient. The scythe also is a necessary implement in the nations most advanced in agricultural methods. But, with the advent of the horse reaper and mower, these crude hand implements ceased to occupy any important place in modern agriculture.

EARLY ENGLISH MACHINES.

It is a remarkable fact that the operation of reaping should have been carried on for centuries with the sickle and scythe as the only reaping implements. Yet, such was the case, for almost nothing was done toward constructing a reaping machine until near the close of the eighteenth century, and almost one-third of the nineteenth century had passed before a practical machine was constructed. For thousands of years the sickle had been the only means of cutting grain, with the exception of the scythe, which came into use in the later centuries. But now a new era was ushered in—an era in which the reaping process was revolutionized and the possibilities of grain growing extended by making the labor of gathering the grain one of the smallest factors connected with the industry. There were a few attempts made toward constructing a reaping machine even during this long period when the sickle held sway, but they were rude affairs and were of little consequence. It is thought, also, that some such machines were in use by the ancients, of which we have no records, but this is only conjecture.

The first mention in history of a reaping machine is one described by Pliny during the first century, as in use in the fields of Gaul. (See Pl. I, fig. 3.) It was not a true reaping machine, but a "header," consisting of a large hollow frame, mounted on two wheels, and set with teeth along its front edge. These teeth caught the heads and tore them off, after which they were raked into the box by an attendant. This machine, like all the early forms, was pushed by an animal yoked behind it. Palladius gives a similar account of the machine, and adds that "the driver can set the teeth high or low, and that a few goings over the fields will cleanly reap it if the ground is smooth." As this mention by Palladius was made in the fourth century, it is probable that some form of the machine was in use for many years, but nothing very practical came of it, and it seems to have been forgotten for centuries.

But now we come to the age when inventors began turning their attention to machines to lighten the labor of harvesting, to a time when competition was becoming more fierce, labor more costly, and any saving of time a gain to civilization. The first of these reaping machines was after the plan of the ancient header of Gaul. A man by the name of Capel Lofft, of Britain, first suggested the idea of a reaping machine, in 1785, probably as a result of the proposal made in 1780, by the Society of Arts, for a premium to be given the author of such an invention. This machine was probably never built, but existed only in the model or on paper. Little is known of its construction, and it is of interest only as being the first one suggested. In 1786 or 1787 a machine was constructed by William Pitt, of Penderford, England, which was in reality a header, but which was constructed on a principle somewhat different from the Lofft and Gallic machines, although doubtless suggested by them. Instead of a row of fixed teeth, a cylinder fitted with rows of comb-like teeth was placed horizontally on the front part of the frame and made to revolve by the power transmitted to it from the wheels. As it revolved, the inclined teeth caught the heads and carried them over the cylinder into the box of the machine. The animal was of course attached behind, which was a characteristic method of hitching in these early forms, since it was necessary that the grain should not be trodden upon, and no one had as yet thought of the side cut.

In 1793, two men by the name of Cartright each invented a machine for mowing and reaping, but descriptions of them are wanting. The reverse is the case with a machine invented in 1799, the name of the inventor being wanting but the description being known. It is described as cutting the grain close to the ground by a number of knives on a wheel that revolved upon a circular piece of sheet iron, to which were riveted a number of steel points. These points were pushed into the standing grain and served not only to hold it but acted also as one-half of a pair of shears (the revolving knives being the other) by which cutting was effected. The grain, falling upon a platform, was swept by a rod, fixed to the axle of the wheel, off the

FIG. 1.—FORMS OF EARLY CUTTERS (CIRCULAR MOTION).

FIG. 2.—FORMS OF EARLY CUTTERS (RECTILINEAR MOTION).

platform and laid in the form of a sheaf out of the way of the next course of the machine. Nothing more is heard of the machine, however, and if it ever advanced beyond the model it was probably a failure. It possessed some valuable features, however, if properly constructed, and seemed far in advance of the ideas of that time. The revolving-knife principle which it embraced was a favorite among the early inventors, after the headers had proved to be failures. The headers formed the first type of cutters or severers, the revolving knife the second, and the reciprocating knife the third and most successful type. The revolving principle was naturally suggested by the motion of the sickle or scythe, linked with the revolving of a wheel.

A man by the name of Walker made a two-horse machine in 1799, but it was inefficient and was soon forgotten.

The first machine of importance working on the revolving-knife plan was that of Joseph Boyce, of London, also built in 1799, which was the first English machine patented. It had a vertical shaft, to which were fastened a number of blades. This shaft was made to revolve by power transmitted from the wheels on which the machine was mounted. It had no contrivance for gathering the grain to the knives or for laying the cut grain in a swath or in gavels. The next year a man by the name of Mears attempted to adopt shears as a cutting apparatus on a machine which he worked by hand, but it was not successful, since neither the shearing apparatus nor the mode of applying the power was practical. During the next four years nothing of importance appeared, although a few attempts were made both in Europe and in the United States. Two machines by an anonymous Frenchman are mentioned, but details concerning them are meager. We only know that "one was on the rectilinear motion, advancing only, and the other on the circular motion, continuous and advancing." A few scattering inventions were made in the United States in the early part of the century, but they were unimportant.

The next important invention was by Plucknet, of Deptford, in the year 1805. It consisted merely of a rotating circular plate, toothed at the edges, entirely destitute of any gathering apparatus, so that, if it cut at all, it would leave the grain in a tangled mass. It gained no reputation and was speedily abandoned.

The following year Gladstone invented a machine with a circular revolving cutter having a smooth edge. It was supported on a carriage frame with two main wheels and a pair of long shafts projecting forward and to one side, so that the horse walked beside the grain, pulling the machine, this being the first machine to be drawn. The circular cutter was overlapped by a sort of shield, armed with pointed projections which served to gather the grain and hold it until cut. It had outside and inside dividers, and a complicated gathering apparatus was used, consisting of a platform above the rotating knife, on

which the grain fell and from which it was swept by a rake, leaving it in small bunches. It was very ingenious, but failed on account of the complicated gatherer.

In 1808 Mr. Salmon, of Woburn, brought out a machine containing some new features, the most important of which was the cutter used. This consisted of a row of vibrating knives acting over stationary blades, and was the first vibrating cutter. It was the first to combine the reciprocating and advancing motion, and was the first hint at the third class of cutters, or those with a reciprocating knife. The plan of delivery was somewhat in advance of the day, consisting of a vertically working rake, driven by a crank in the rear of the machine. By this means the grain was raked from the platform, which was placed just behind the cutter. The machine promised much, but owing to certain defects it was a failure and was abandoned. This same year Plucknet brought out an improvement upon his machine of 1805, including a side draft and a self-delivery apparatus. Up to this time none of the machines had approached perfection, and few had been operated beyond a mere trial. Little attention was paid to them by practical farmers, and they constituted but a small factor in agricultural operations.

During the next three or four years nothing was accomplished worthy of mention; but in 1811 a Mr. Smith, of Deanston, built a machine (Pl. III, fig. 1) which he kept improving until 1814, when it performed its work better than any which had appeared up to that time. It was designed primarily as a mowing machine. It had the rotating-cutter principle, and consisted of a frame-work mounted upon two wheels, bearing an inverted conical drum with a projecting circular knife at its lower and smaller end. This drum was made to revolve by motion transmitted to it by a system of cogs connected with the wheels, thus severing the grain and bearing it to one side into a swath. Two small wheels beneath the drum kept the knife at a proper distance from the ground, and a contrivance was added by which this distance could be increased or decreased. It followed the old plan of having the horses hitched behind the machine.

About this time a man by the name of Kerr brought out a machine working on the same principle, and quite a dispute arose between the two men as to who was the real inventor. From the circumstances of the case it seems probable that the idea was original with both men, as has happened many times in important inventions. Both machines became popular in Scotland, and received prizes from the Highland and Dalkeith societies.

In 1811 two other machines were brought out, both by Northumbrians, John Common and Donald Cumming. The latter's machine was patented and was a novel affair. The cutter "consisted of a series of revolving disks placed on two flat bearers, the latter forming an angle whose point faced the grain. As the machine moved for-

FIG. 1.—SMITH'S REAPING MACHINE (1814).

FIG. 2.—OGLE'S REAPING MACHINE (1822).

FIG. 3.—BELL'S REAPING MACHINE (1828).

ward the grain was cut between the revolving disks. A series of 'hold fasts' projected before the cutters to lead the grain up to them. The grain was gathered by revolving vanes or drums and carried off to each side of the machine by endless webs."¹ This machine had some pretensions to efficiency, and foreshadowed some of the appliances of modern machines, but it was too complicated and visionary to be practical, and was soon forgotten. Common's first machine was of little value, but the next year he brought out another, with an endless web on two rollers which gave a side delivery, while his knife had some resemblance to the famous Hussey pattern of the Western Continent. It was not patented, and was soon forgotten.

The next machine which made its appearance was one invented by James Dobbs in 1814. Dobbs was a dramatist, and he worked the machine on the stage upon a small field artificially planted with wheat. The cutter was circular with a toothed edge. The body of the machine resembled a wheelbarrow, and was pushed forward in the same way, the drive wheel being placed between the handles. It had quite a complicated system of rollers and dividers to lead the grain to the cutter, but it was not practical, and was probably remembered only because of the manner in which it was introduced.

The next year (1815) a man by the name of Scott, of Ormiston, produced a machine with a rotating cutter consisting of a wheel carrying 16 small-toothed sickles and having projecting prongs in front like Gladstone's. The gatherer consisted of an inverted conical drum something like Smith's, but with 24 jointed prongs projecting from it to act as collectors or rakes in carrying the grain from the cutter to the ground. It had several minor contrivances, but did not work beyond a trial.

Nothing further of importance came out until 1820, when Mann, of Roby, constructed his model of a reaping machine. This attracted much attention, but the full-sized machine was not constructed until 1822, and, when it did appear, it was so complicated that success was doubtful. He continued to work on the machine, however, until 1832, at which time it could be described as follows: A wheeled frame bearing a polygonal revolving cutter, with a series of revolving rakes for carrying the grain to the swath, and an apparatus for cleaning the rakes. The machine was drawn, and the line of draft, although applied in front, was parallel to the line of motion. The special feature was the twelve-sided cutter, which was expected to be more efficient than a circular one. It did not come up to expectation, however, and although used to some extent in the field, it never came into general use.

We now come to one of the most noted inventions in reapers, that of Henry Ogle, a schoolmaster of Remington, whose machine (Pl. III, fig. 2) came out in 1822. Ogle was a genius of high order and well

¹ *Journal of Agriculture*, Edinburgh and London, 1853-55, p. 615.

deserves the honor bestowed upon him. The machine itself never became popular, but the principle of the cutter together with the reel which he constructed is found incorporated in every successful reaper since that time. He constructed a model of a machine in 1822, but not being a workman himself, he submitted the making of a full-sized machine to Thomas and Joseph Brown, of Alnwick, England, who afterwards helped him in his design. Hence the machine is sometimes spoken of as the Ogle and Brown machine. It resembled the skeleton of a cart with wheels and shafts, the horse walking ahead beside the standing grain and the cutting apparatus extending to the right side. This cutter consisted of a frame whose front bar was of iron armed with rows of teeth 3 inches long projecting forward. Directly under these lay the cutter, a straight-edged knife. There was a reel resembling the modern form, which pushed the grain backward onto a platform situated behind the cutter. This platform if hinged could be used as a dropper; if fixed, the grain could be raked off in gavels. In the words of Mr. Ogle this platform when hinged "is lifted till as much corn is collected as will make a sheaf and let fall by a lever upon the frame, when the corn slides off, when it is a little raised again. It was found, however, to answer better when it was put off with a man and a fork toward the horses, as it is easier bound and leaves the stubble clear for the horse to go upon." From the position of the lever a seat was evidently provided for the operator.

Here, then, we have the foreshadowing of the future reaper—the reciprocating knife over stationary fingers, the reel, the platform, and dividers. It was drawn from the front and side and was borne on two wheels, as are all modern machines. To be sure, the dividers and platform had been used before, while Salmon had made a kind of reciprocating knife in 1807; yet the latter was very unlike this, acting more on the principle of the scissors. Ogle should be given the credit for the first reciprocating knife combined with stationary fingers, together with a very happy combination of other lasting features of the reaper; and while the machine never became a great success, owing in a great measure to the disfavor in which reaping machines were held by laborers and to the threats made upon the manufacturer, yet it was the embryo of the modern reaper and holds a prominent place in the development of these machines.

Up to this time no machine had been in any great degree successful in the field. To be sure, some of them, such as Smith's and Kerr's, had been used to some extent, but the greater number had not survived a few tests. We come now to a machine which was brought into use in considerable numbers and which was used for some time in the fields of England and Scotland, some even being sent to this country. It was invented by Patrick Bell, of Carmyllie, Forfarshire, in 1826 and put in the field in the following year. Bell was a minis-

ter, but, being quite familiar with agricultural operations and having an ingenious turn of mind, he applied himself to the task of inventing a reaper, which he saw was badly needed at that time. After much consideration he constructed an apparatus which he thought would do the work, making his first tests on an artificial field of oats in his workshop. After about two years' experimenting he brought out what has since been known as the Bell reaper. (Pl. III, fig. 3.) It consisted of a wooden frame mounted on wheels, with a pole extending backward, to which the horses were attached. The cutting apparatus was on a shearing or clipping principle and consisted of thirteen stationary blades about 15 inches long and about 4 inches wide at the wider or base end, above which were placed twelve movable blades of about the same size, fastened on pivots so as to be moved back and forth over the stationary ones below, thus giving a motion like to that of so many pairs of shears. The power was communicated to the movable blades by connecting their rear ends with a sliding bar, made to move by an oscillating rod connected with a worm flange on a revolving shaft. A canvas moving on rollers and sloping to the cutters carried the cut grain to one side, where it was left in a continuous, even swath. The machine was also provided with dividers and with a reel much like the modern forms.

This machine, although built on the wrong principle to ever become a great success, was used for many years in various parts of England, or until the introduction of the better machines springing from the inventions of Hussey and McCormick, the two Americans whose machines were made the basis of the wonderful development in harvesting implements which took place within the next fifty years. With the introduction of these American machines there entered a foreign element into English invention, and from this time on the machines of importance were various improvements upon three types—Bell's, Hussey's, and McCormick's. Of course, there were sundry other inventions which did not include the principles of these machines, but they were of little consequence in the real development of the reaper. Up to 1831 there had been 2 French, 1 German, 33 English, and 22 American inventions recorded, with a few unimportant attempts in this line from various other sources; but to follow any except the machines related to the three mentioned would be not only impracticable but useless.

Before considering those machines, which combine both English and American elements, it would be well to notice what should be conceded to English inventors in this interesting development; and although American inventors from this point take almost the entire burden, it is undoubtedly true that they received their first ideas from their brothers across the Atlantic.

For the reciprocating knife over stationary fingers and for the revolving wheel we are undoubtedly indebted to Henry Ogle, whose

unique machine contained so many elements of the modern reaper. For the platform on which the grain falls we must look first to Gladstone, who in 1806 used such a contrivance on his machine.¹ The machine failed, but the principle of the platform has survived. As to a grain board or divider it is somewhat uncertain who should be given the credit of advancing this idea. We find that Dobbs, in 1814, had a "complicated process of rollers and dividers to lead the corn to the cutter,"² while Gladstone's machine, with its stationary fingers above the revolving knife, and Salmon's with its clipping cutter, undoubtedly had something of this sort. Gladstone's machine contains the first hint toward a self-rake, while Salmon repeated it in a different form. Cummings' machine of 1811 contained a reel. Ogle must be credited with the first dropper in 1822, and Gladstone with the first side-draft machine in 1806.

We must credit the English, then, with the first reciprocating cutter and divider, the platform, the reel, and side-draft features, and with the first forms of the dropper and self-rake; but it is to American ingenuity that is mainly due the rapid perfection of the practically successful grain harvester. Thus far the English came alone, but from that point their influence began to wane and American genius completed the remaining chapters of the development.

Of the machines³ in which both English and American principles were blended there are some that are of special importance, but few that aid us materially in tracing the true development of the reaper.

The Hussey machine, introduced into England near the middle of the past century, consisted of a low frame mounted on two wheels, the larger being the drive wheel which transmitted the motion to a vibrating bar, bearing pointed blades or sections working through slots in iron fingers projecting forward on the front of the cutter bar. Behind the cutter was placed a platform to receive the cut grain, from which it was raked by a man riding on the machine. The machine was exceedingly simple, and was without reel or any complicated apparatus.

The McCormick machine, introduced about the same time as the Hussey, was somewhat more complicated, but had the same principle of a vibrating knife, excepting that in this case the knife had a serrated edge with only a wavy outline instead of pointed sections as in Hussey's. The fingers also differed somewhat from the Hussey type, and a reel was added to make the cutter more effective, but no place was provided on the machine for the raker, who was compelled to walk. Both machines were drawn, the horses being in front of the machine and beside the standing grain.

¹ *Scientific American*, July 5, 1896.

² *Journal of Agriculture*, Edinburgh and London, 1853-55, p. 617.

³ The descriptions of these English-American machines are taken from Jacob Wilson's *Essay on Reaping Machines*, published in *Transactions of the Highland and Agricultural Society of Scotland*, 1863-65, p. 123.

With these brief descriptions it is possible to glance with more intelligence at some of the modifications brought out by the English inventors. It should be noted here that many of the machines constructed at this time combined both grass cutting and reaping appliances, and were used for both mowing and reaping. Thus the mower was born in combination with the reaper, and it was only in later forms that it became a separate machine.

It was at the great exhibition of 1851 where such a golden opportunity was given for the display of inventions that a widespread interest became manifest in regard to reaping machinery. This was occasioned chiefly by the appearance of the Hussey and McCormick machines which were entered in competition at this time. In addition to these, a machine was contributed by a Mr. Garrett which, however, was the invention of a man by the name of Tolemache. It possessed the advantage of a side delivery, and the horses were yoked one before the other. Numerous models were exhibited but these were the three of importance.

The knife in McCormick's machine had a serrated edge with numerous obtuse blades riveted into the bar, forming very obtuse angles, so that it acted as a saw, requiring the aid of a reel to hold the grain against it. Hussey's, on the other hand, had pointed knives which formed very acute angles with the guards, and the cutting was more in the nature of clipping or chopping. It was more likely to choke than McCormick's, and one of the chief objections to it was that it required too fast a pace of the horses to keep it cutting well. Garrett's was inferior to both these machines, and in the trial McCormick won the medal. Not being satisfied with this, Hussey asked for another trial, which took place sometime afterwards and in which his machine carried off the honors over McCormick's.

Hussey's machine for some time before this exhibition had been manufactured by Dray & Co., of London, and was called Dray's Hussey, while in 1850 Richard Brooman took out an English patent for McCormick's machine. During the fifteen years following this exhibition, the progress in invention was marvelous both in the United States and in England.

For purposes of discussion these English machines may be divided into two classes: (1) Those having a mechanical delivery, and (2) those having a manual delivery. In the first class, Crosskill's improvement of Bell's machine in 1852 was one of the most important. The improvement consisted in the substitution of McCormick's serrated, vibrating knife in place of the scissors form of cutter and in substituting for the revolving canvas a series of endless bands of vulcanized rubber, fitted with projecting pieces of wood. Burgess and Key made an improvement on the McCormick by placing on it a swath delivery apparatus, in the form of a series of Archimedian screws, which laid the grain in an even swath. It also contained a few minor

improvements such as a revolving cone which acted as a divider, and the height of cut could be regulated while the machine was in motion. Another important machine was Lord Kinnaid's, which had McCormick's cutting apparatus with the addition of his own patented delivery apparatus, consisting of endless bands over a smooth surface, being similar to that of Bell's. The horses walked at the side one before the other, the rear one being hitched to the shafts. It was a simple machine of light draft.

McCormick's English machine in 1861 differed from the preceding in delivering the grain in gavels rather than in the swath. It was virtually the American self-rake, which will be described in the next chapter and which had by this time become very common in America. It had a series of revolving vanes, one of which was made to sweep the grain from the platform out of the way of the next round. It was manufactured by Burgess and Key.

A machine introduced by Samuelson was similar to the McCormick in having a self-acting sheaf delivery. His 1863 model was an improvement over the one of the year before, having four (formerly six) rakes attached to an upright shaft in such a manner as to admit of a free, ascending, descending, and horizontal motion. Two of these rakes were dummies, while the other two both gathered the grain and raked it from the platform, which was quadrant shaped, so that the grain was left to one side as it was by McCormick's machine. The height of the cut was easily regulated.

In 1862 Kemp, Murray, and Nicholson introduced a machine in which a self-delivery apparatus was applied to an "improved Hussey." It consisted of a self-acting tipping platform and a revolving reel with four arms, one of which was longer than the others. At the time when the long arms came in contact with the grain, the tipping board fell, leaving a well-formed sheaf at regular intervals. A single attendant was needed to guide and control the machine, and the size of sheaf could be regulated at will. This concludes the list of important self-delivery machines up to 1864.

Of the manual forms which constitute the second class, the following may be mentioned: Picksley and Sims's machine, which was the patent of Mr. Bartlett and which was quite an important machine of this class. It had two wheels with a guard or castor wheel ahead to prevent the cutter bar from coming in contact with the ground. The cutter was on the clipping principle, and was attached to a vertical vibrating bar allowing a very free motion. The grain fell upon a platform with a spring which gave way with a certain weight, thus tipping and dropping the sheaf with the aid of the raker, who sat on the machine. It was really a combination of the manual and self-delivery types.

Gardner and Lindsay's improvement of the Hussey was a very popular machine in Scotland, and was among the first of the improved

Hussey's. The machine had two wheels and a castor in front. The cutter bar was hinged and folded, this being the first record we have of such a bar among English models.

Kemp, Murray, and Nicholson also made an improved Hussey, the improvement consisting of an increased size both in the driving wheel and in the off-side traveling wheel. The speed of the knife was also increased so as to decrease the pace of the horses. The height of cut could be regulated and a contrivance was attached for throwing it in and out of gear. Later improvements were applied to the cutter, in which the finger bar was ribbed or flanged so as to increase strength, while the knife bar received a greater freedom of motion, thus making it less liable to choke and causing a lessening of draft. The grain fell on a platform tipped by the foot of the raker, who, with the assistance of the rake, could make a very neat gavel. A pole was introduced, which could rise and fall, thus making it easier for the horses than a rigid one.

These are some of the improvements made in England on the Hussey machine up to 1862. Burgess and Key also made at this time a manual delivery which became a favorite on small farms. It differed from some of its class in having both traveling wheels as drivers, and in having them in advance of the cutter bar, the castor being behind it. Besides a tipping platform, it had a conical screw divider which revolved inward and was driven by the weight of the grain, thus not only separating the grain, but pushing it toward the raker. It was also used as a grass cutter. Cuthbert, of Bedale, also improved the Hussey, making a very good machine. He increased the size of the drive wheels and suspended the cutter bar by a spring so as to lessen the friction. The speed of the knives was made less, but the stroke longer than in the original Hussey. Shafts were used instead of a pole, thus giving steadiness of draft. The height of cut could be regulated by tipping the machine.

Jack & Son, of Maypole, began the manufacture of reapers in 1859, by improving the Hussey, and succeeded in making good machines, although their improvements were mostly in details. In 1860 Brigham and Bickerton introduced their "Buckeye," an improved Hussey with a hinged cutter bar adjustable to different heights. It had a light draft and was almost too frail. It was both a grain and grass cutter with different cutter bars for each operation.

Samuelson's "Patent Eclipse" was a one-horse machine, simple and light, and with an absence of gearing, the driving wheel communicating its motion directly to the knife by means of a lever pinion.

This concludes most of the important manual delivery machines up to about the year 1864, and enough has been said to show the development of the English machines up to that date, and to make it evident that much of it was due to American inventors.

It may be said that most of the above machines which have the

clipping principle (as did most of the Hussey type) come under the head of grass mowers and were ordinarily used as such, although they could be used as reapers. Thus we see that the mower advanced in great measure, hand in hand with the reaper, so that it is almost impossible to separate the two in the early stages of development. Later we see that the point at which they did diverge was in the construction of the knife, the reaper taking a toothed-edge section and the mower the more rapidly vibrating sickle with the smooth-edge sections. At this point it would be well to pause in noting the development of English machines and turn to America, the birthplace of the practical reaper. All the successful English machines at this time were but modified forms of the American machines, so that it is to this country that we must look for the original patterns and the true development of harvesting machines. The crude English machines of the early part of the century set the American inventor thinking, and in due time he laid the foundation upon which the reaping machines both in America and England have since been constructed. We can here leave the English inventors, conceding to them the origination of the idea, and the foreshadowing of some valuable principles, but for the real development we must look to America.

AMERICAN MACHINES.

The development of reaping implements has been traced in broken steps from the rude sickle of the ancient Egyptian through the most important English inventions down to the time when American machines were introduced, by which all inventions were afterwards affected. Attention is now directed to the history of development along this line in America, the birthplace of the successful reaper. In no respect have American inventors exhibited their genius to a greater degree than in the development of the reaping machine. They have virtually fashioned their sickles into harvesters. They have emancipated the farm laborer from a galling task and made possible a wonderful progress in agriculture.

REAPERS.

[The first patent granted in America for a reaping machine was to Richard French and T. J. Hawkins of New Jersey, May 17, 1803. This is the earliest record that has been found of an effort to build a reaper, but no reliable description of the machine seems to have been preserved. It had three wheels, one of which entered the standing grain, but other information seems to be lacking.¹

The earlier American inventions were mostly along the lines of grass cutters, but as reapers and mowers were at first so closely related they should be discussed together here. On December 4, 1812,

¹Eighth Census of the United States, 1860, volume on agriculture, p. 20.

Peter Gaillard, of Lancaster, Pa., was granted a patent for a grass-cutting machine, the first of its kind in America, all machines before this time being intended for cutting grain and not grass; thus the idea of mowing grass by horsepower with a machine built solely for that purpose originated in America, although the machine invented by Smith, of Deanston, in 1811, was designed primarily for cutting grass (see p. 14). Gaillard's machine was of little consequence; but on February 13, 1822, Jeremiah Bailey, also of Pennsylvania, took out a patent for a grass cutter, which gained quite a reputation throughout the country. It was on the revolving cutter plan, and consisted of a rectangular frame supported by two large wheels, one being inside the frame and acting as a drive wheel, the motion being transmitted to the rotating cutter through a series of cogs. The cutter was shaped like a low-crowned hat, the crown being 3 feet 5 inches in diameter and the brim about 1 foot wide. This was of wood, with the exception of the knife which formed the edge of the brim. The knife was kept at the proper distance from the ground by a shoe, so arranged that the distance could be increased or diminished at will. The horse walked ahead beside the grass. This was the first mower that met with the slightest success, and it was used to some extent in practical work.¹ It was the first to indicate the principle of a flexible bar by this arrangement for keeping the knife at a uniform distance from the ground.

On May 18, 1825, a patent was granted to E. Cope and J. Hooper, jr., for a machine which was really only an improvement of the Bailey, as it had the same principle but was simpler.

The next patented invention worthy of notice is one by Samuel Lane, August 8, 1828, for a combined harvester and thresher. It was ingenious, but too complicated, and was never used with success. It is of interest as being the first attempt at this combination. Various other inventions made during this early period contained nothing important and need not be mentioned.

The next machine that should be noticed is one patented by Erastus Ingersoll, May 7, 1830. It was a grass cutter of the rotating-cutter type, and, although it never attained much distinction, it was a clean invention that should not be forgotten.

The next invention was one of considerable importance, and, although it was built as a reaping machine, its cutting apparatus was an important step in the improvement of both mowers and reapers. The invention was that of William Manning, of New Jersey, patented May 3, 1831. It had two ground wheels fixed to the same axle, from which a frame extended, having a bar attachment held in place by two arms, and provided with teeth 6 or 8 inches in length, extending forward into the grain. A flat bar of iron lay upon this bar, bearing spear-shaped cutters sharpened on each of their edges. These were

¹ Farm Implement News, Aug. 3, 1893.

about 6 inches long, and cut the grain as it was held by the teeth.¹ This was substantially the scalloped sickle, and was Manning's original patent, resembling much the celebrated cutters of Hussey and McCormick, which afterwards became so important. It had a grain divider, the first on record in America.

In 1833 there were three inventions before the Hussey patent was granted, one of which was by William and Thomas Schnebly, and had an intermittent endless apron for forming gavels. It was not a success.

Obed Hussey, of Baltimore, Md., patented his world-famous machine December 31, 1833. About this time experiments were in progress with a machine invented by Cyrus H. McCormick, of Virginia, which, with some later improvements, was also destined to go down in history as one of the most important machines in the development of reaping machinery. This machine is reported to have been first used in the harvest of 1831, but no patent was taken out until June 21, 1834.² These are the two machines which stood out as models for all others that were afterwards successful.

Hussey's machine (Pl. IV, fig. 1) as patented and first constructed was mounted on two wheels to the rear and somewhat to the right of which extended a platform with the cutting apparatus on its front edge. This platform was at first supported in the rear by a roller and later a wheel was added at its outer edge. The cutter was the unique part of this machine, and consisted of a series of slotted iron fingers through which vibrated a number of triangular knives fixed to a flat bar. The fingers or guards were 7 or 8 inches long, with a slot for admitting the knife and were fixed solidly to the front edge of the platform, extending forward into the grain. The knife consisted of a series of triangular plates riveted to a flat iron bar and forming a kind of coarse-toothed saw. One end of this saw was attached to a pitman moved by a crank and receiving its motion from the main axle by means of cogs.

McCormick's machine (Pl. IV, fig. 2) at this time (one year before it was patented) was somewhat more complicated than Hussey's and not quite so substantial. It was drawn by one horse hitched in shafts and walking beside the standing grain. The drive wheel was situated almost directly behind the horse and through a series of cogs gave a reciprocating motion to the cutting knife. This knife was about 4½ feet long, with an edge like a sickle, and worked through wires projecting before it, which held the grain while being cut. Behind this was an apron or platform 5 or 6 feet long, made of thin plank, from which the grain was raked by a man walking behind the machine. At the outer end of the platform next to the grain was a partition consisting of a cloth-covered frame, to divide the cut from the uncut

¹ Eighth Census of the United States, 1860, volume on agriculture.

² Who Invented the Reaper? R. B. Swift, p. 6.

FIG. 1.—HUSSEY'S REAPING MACHINE (1833).

FIG. 2.—McCORMICK'S REAPING MACHINE (1834).

grain. There was a reel 6 or 7 feet in diameter and as long as the knife, fastened just over the cutter and made to revolve by a band connected with the main axle. This is essentially the description of the machine as given in the *Mechanics' Magazine* in 1833 by an Englishman who saw it working in the harvest of that year, and it may be considered an unprejudiced and at least a fair description. The patent specifications of 1834 described the machine essentially as follows: It was borne on two wheels, with a platform back of the cutter, so arranged that the sheaves were to be raked off to one side, out of the way of the next round. The larger wheel was on the side farthest from the grain, and by means of a crank and cogs caused to vibrate a straight-edged knife, which is described in the specifications as "having the edge either smooth or with teeth, either with stationary wires or pieces above and below and projecting before it for the purpose of steadying the grain while cutting, or using a double crank and another blade or vibrating bar."

The machine also had a divider to separate the cut and uncut grain and a large reel to hold the grain against the knife. The patent also specifies that it is to be either drawn or pushed. Thus it is seen that the machine as patented corresponded very closely with the one described as in use in 1833, so that, while the patent was not granted until the next year, McCormick as well as Hussey had his machine at work in the harvest of 1833. However, as was stated before, McCormick's machine was undoubtedly invented prior to this time, as he had a machine which operated in the harvest of 1831. According to McCormick's own statement in his communication filed when seeking for an extension of his patent in 1848, this early machine was essentially the same as that patented in 1834. Be that as it may, it is certain that he had a machine invented in 1831 and that it was tried in that year, but that it was a success is not so evident. Hussey, on the other hand, makes no claim to having invented his machine before 1833.

The most important part about each of these machines is the cutting apparatus, and these being the pioneers in successful cutters they should be examined in detail.

Hussey's cutter (Pl. V, figs. 1, 2) is really a novel and surely an original feature of his machine. Although a vibrating knife had been used before, it was not like this, and nothing resembling the slotted fingers had ever been known. These fingers, or guards, were formed of a top and bottom piece, joined at the point and near the back, but leaving a slot through which the knife played. They were fixed securely into the bar on the front edge of the platform at intervals of about 3 inches, and extended forward into the grain about 7 or 8 inches. The cutter, or saw, was formed of thin triangular plates of steel (being made from old saw blades in the first machine) which were riveted side by side in a flat bar. They were $4\frac{1}{2}$ inches long and

3 inches wide at the base, but terminating in almost a point. They were sharpened on both edges and beveled from both sides, unlike the present mower sections, which are beveled from above only. The action, then, was not on the shearing principle, as in Bell's machine, but was rather a chopping or clipping action. The patent specifications state plainly that "the saw teeth shall play clear over the guards both above and below," so that the invention could not have been copied from Bell's shearing plan, as has sometimes been claimed. The doubly beveled sections and closed guard were soon found to be faulty, as the cutters were especially liable to clog. Another feature had considerable to do with the clogging and also increased the draft greatly, i. e. the acute angle which the blade formed with the guard. In order to remedy this difficulty some changes were soon made. The blade was shortened and made more obtuse. About an inch of the edge of each blade near its base was left flat below and beveled only from above, in order to shear the trash and grass which gathered in the back part of the slot, and, lastly, the guard, instead of having a closed slot, was open at the back and upper part, this last modification constituting the principal feature of Hussey's patent of August 7, 1847. As time went on and many inventors applied themselves to the improvement of this form of cutter, more and more of the edge of the blade was left in contact with the guard below, and the blade became more and more obtuse, approaching more nearly the shape of the mower sections of the present day. Thus it is seen that while Hussey's invention contained features vital to the reaper, it had a greater effect upon the development of the mowing machine, and was more strictly a type of mower than of reaper.

McCormick's cutter (Pl. V, figs. 3, 4) as first used consisted of a straight blade vibrating between projecting wires which held the grain while being cut. This blade, as the patent specifications say, was "either smooth or with teeth," and very probably the first machines tried had a perfectly smooth blade, which very soon gave place to the serrated form. The arrangement of projecting wires to hold the grain while cutting was also used at first, but later a sort of finger was devised consisting of a strap of iron extending forward over the blade and then bending back under it, leaving an opening at the back part and beneath. These guards were used until 1839. In 1840 the fingers were changed to double closed ones of the Hussey type, but, as in Hussey's machine, this closed finger had a tendency to cause clogging, and was changed for a later style as patented January 31, 1845. In 1841 a change was made in the serrations on the blade, making alternated groups of teeth to point toward each other, so as to incline toward the guards in the reciprocating motion.¹ Then came the modification of the guards, as above mentioned, changing them to spear-shaped projections, flattened horizontally. Both these changes were

¹ Who Invented the Reaper? R. B. Swift, p. 36.

FIG. 1.—HUSEY'S EARLY CUTTING APPARATUS.

FIG. 2.—HUSEY'S CUTTING APPARATUS AFTER IMPROVEMENT
PATENTED AUGUST 7, 1847.

FIG. 3.—MCCORMICK'S EARLY CUTTING APPARATUS

FIG. 4.—MCCORMICK'S CUTTING APPARATUS AFTER IMPROVEMENT

incorporated in the patent of January 31, 1845; also "the curved bearer for supporting the blade," the reversed angle of the blade, the construction of the guards so as to form angular spaces in front of the blade, the combination of bow and dividing iron for supporting the grain, and the position of the reel post on the machine.

In 1852 McCormick adopted the open finger guard¹ of the Hussey type, and made the blade slightly scalloped on the cutting edge. Later the scallops were made more pronounced, finally developing into the obtuse-angled serrated section, resembling that used on reapers and binders to-day. It must not be thought, however, that the present forms of guards and sections are Hussey's and McCormick's ideas alone, for they are really the result of improvements made by various individuals on the original Hussey and McCormick inventions. These two men were not left long to themselves, for as soon as the practical form was established other inventors took up the work and by various improvements aided in the development.

As to which of these men should have more credit for originality of invention, or for furthering the development of reaping machines, it is difficult to decide. Certain it is, however, that many of the principles incorporated in these machines had at least been hinted at before, and whether or not these men knew of such inventions can only be conjectured. Although in that day news did not travel so rapidly, it is very probable that the first idea of vibrating cutters was imported from England, where it had been shown in the remarkable invention of Ogle of 1822. It must be remembered, also, that Manning, in 1831, had used a vibrating cutter with spear-shaped knives, and this step was as great, so far as the invention was concerned, as that taken by either of the men whose machines we have been considering.² Ogle also had a platform, so that this was not new. Manning had a divider, while Bell and Ogle both had reels, so that McCormick was not first with that feature. Thus, it is seen that the foundation principles of both machines might have been suggested, at least in part, by early inventors. But, be that as it may, it does not concern us greatly in a study of the evolution of reaping machinery. The fact that both these men made valuable inventions on which the real development of reaping machines has been based, is sufficient to give them places of great honor among the promoters of agricultural progress. It is undoubtedly true that in their later improvements each man was in some measure influenced and aided by the other. Thus, Hussey's knife became more like McCormick's and McCormick's more like Hussey's as time went on. McCormick profited by the Hussey idea of the guards, and Hussey made use of McCormick's principle of balancing the machine on two wheels. Hussey's cutting apparatus was the most unique and probably the most orig-

¹ Who Invented the Reaper? R. B. Swift, p. 40.

² American Agricultural Implements, R. L. Ardrey, p. 81.

inal, while McCormick's tactful combination of so many essential features, whether original or not, did wonders toward furthering the development of harvesting machinery.

In the early trials of these machines the honors sometimes were taken by one and sometimes by the other; but it was noticed that, while Hussey's was simpler and more durable, it pulled heavier and possessed the disadvantage of requiring the wheat to be bound before a second round of the machine, since the sheaves were raked directly backward off the platform. It was, however, more to be depended upon than McCormick's, excepting in wet or green grain, where McCormick's seemed to have the advantage.

Few of either machine were sold for several years. According to McCormick's own statement, in an account of his progress, written for Philip Pusey, esq., of England, "No machines were sold until 1840, and I may say that they were not of much practical value until the improvements of my second patent in 1845. Up to this period nothing but loss of time and money resulted from my efforts."¹ The improvements referred to seem to have increased greatly the efficiency of the machine, for in 1851 more than one thousand were sold.

Having considered the two foundation machines, we may now notice the various improvements and modifications which have appeared in developing the machines of the present day. The patents and inventions are so numerous, however, that it will be possible to give only the most important, or those containing some essential features of the later machines; and as the mower and reaper were at first often combined in the same machine, some of the earlier patents referring to mowers must also be mentioned. The mower was at first simply the reaper dismantled of its platform and other parts not needed for grass cutting, although separate machines for this purpose were early constructed. As the mower required a higher speed of the knives than the reaper, no successful type of this machine was constructed until a device for accomplishing this end was invented.

Enoch Ambler, of New York, obtained a patent December 23, 1834, about which little can be learned. It is understood, however, that he had the first wrought-iron finger bar with steel guards and shoes. There is some difference of opinion as to the worth of this invention, but the finger bar seems to have been somewhat in advance of the times, resembling the later forms of the McCormick and Hussey machines.

Abraham Randall (or Rundell), of New York, April 22, 1835, patented a curious cutting device, consisting of two sickles or cutters with corresponding points to be operated in contrary directions, thus making a double shear cut with each pair of points, the whole acting as a series of double-acting shears. It was one of the most important of a number of inventions on this principle which were made in this country and in England, one successful mower, the Danford, being

¹ Overlooked Pages of Reaper History, p. 11.

upon this principle.¹ This Randall machine also contained a raking and discharging device, which was among the first attempts at an automatic rake. Up to this time the raking had all been done by hand; but now, after the essential parts of the reaper were worked out, inventors began to endeavor to perfect the machine and to solve the problem of a successful automatic device to remove the grain from the platform.

The early devices for automatically removing the grain from the platform were varied and often crude. It will be remembered that Bell used an endless canvas to lay the grain in a swath at the side, while Crosskill's English modification of McCormick's machine several years later used a number of Archimedian screws to accomplish the same purpose. These and numerous other devices were tried, such as reciprocating bars with pegs to work the grain to one side and rake teeth penetrating a stationary platform below, as in Reed's machine (see below). Finally, among the numerous attempts along this line came that which operated with rakes above a stationary platform, the type from which the self-rake was at last developed. Among the first of this class were the single-rake type, which raked directly backward with a horizontal motion. Others had a rake fastened to the reel, while some had single rakes sweeping a quadrant platform. Finally came the revolving fans, either on a vertical or an inclined axis, one of which raked the platform. Later the vanes or fans were all made alike, each being capable of sweeping the platform at the will of the operator.

One of the first patented inventions which sought to deliver the gavels automatically was that of Schnebly, patented in 1833. It had a horizontal endless apron, traveling intermittently and thus delivering the grain in gavels by the side of the machine. In 1838 Cyrenus Wheeler invented a machine with a revolving endless apron to deposit the grain in a box with a sliding bottom which could be opened, thus dropping the grain in gavels. Jonathan Reed patented a machine March 12, 1842, that had a rake beneath the platform with teeth projecting through the slots to remove the grain in gavels. He also introduced a form of cutter which possessed the peculiarity of serrated guards in combination with serrated cutters, but this never seemed practical. Clinton Foster, this same year, April 18, patented a form of rake which swept across the platform as controlled by the operator, and November 20, 1846, Andrew Cook patented a rake which was attached to the reel, forming a revolving reel rake, the first of its class. This latter machine was afterwards manufactured by Goble and Stewart and had a revolving canvas, back of the platform, upon which the grain was swept by this revolving rake and thus transferred to the ground to one side.

¹ McCormick's original patent provided for a similar device, i. e., two knives working in contrary directions, as well as for the single reciprocating knife afterward exclusively adopted (see *Progress of Invention in the Nineteenth Century*, by E. W. Byrn, p. 198; *American Agricultural Implements*, by R. L. Ardrey, p. 45).

A machine patented by William F. Ketchum, July 18, 1847, although built as a mower, should be mentioned here. The valuable feature was in the cutter bar which was made to sweep the ground only the length of the cutting part, being then angled up to the drive-wheel frame, the present mode of attaching cutter bars. It was in this year, too, that Hussey patented his open-topped guard and McCormick received a patent for a raker's seat on his machine. The next patent for an automatic delivery was that of F. S. Pease, November 14, 1848. It had a grain rake traveling sideways beneath the platform with side slots for the fingers. Mann made one much like this the next year.

On November 21, 1848, Goble & Stewart patented a rotary rake passing horizontally across the platform, and which was "given an unequal motion for the purpose of raking the cut grain in an effectual manner." Daniel Cushing about this time took out a patent for an apparatus with revolving rakes. The next year, January 16, Oliver Barr patented a revolving rake and an inclined platform with a sort of trap door for the grain to fall through, a kind of dropper. This same year Haines conceived the idea of suspending the frame carrying the conveyor, reel, and cutter to axles of the bearing wheels, and hinged the frame to the tongue so that it could be tilted in raising or lowering the cutters, an important improvement.

A. J. Purviance, of Ohio, May 22, 1849, obtained a patent for constructing the platform separate from the other framework so as to convert the machine into a mower or reaper as required. This was the first practical combined machine, and marked the beginning of the long list of such machines both in America and England. On June 12 of the same year an important patent was taken out by Nelson Platt, which was afterwards assigned to Seymour & Morgan, pioneers in the development of the self-rake. It had a self-acting rake sweeping over a quadrantal platform and leaving the grain in gavels at the side of the machine. It was the first of the sweep-rake system which afterwards became so popular. On June 19 of this year J. J. & H. F. Mann patented a device consisting of endless bands delivering the grain into a receiver from which it was discharged in gavels by an attendant.

This brings the history up to 1850, most inventions of any importance made prior to that date having been mentioned. From this time on inventors by the score began turning their attention to perfecting the means of delivering the grain, and patents became so numerous that it will be possible in this treatise to mention only those most essential to the development. About this time, as the machines became more and more in demand, companies began to spring up to engage in their manufacture, so that in a few years the industry became of vast importance and the machines came into use throughout the United States and were rapidly introduced into other coun-

FIG. 1.—AN EARLY FORM OF SELF-RAKE—THE NEW YORKER.

FIG. 2.—A MODERN SELF-RAKE.

tries. Within ten years the mower became practically what it is to-day and another decade saw the foundation of the modern binder practically laid.

The year 1850 was not remarkable for important inventions. E. Danford patented an improvement on a double sickle and produced a mower which was very effective. It was so perfect as to be able to cut through a cock of hay, but the difficulty of keeping the knives free of the gum on their adjacent surfaces was so great that the machine had to be abandoned. On July 1, 1851, Palmer & Williams obtained a patent for a sweep-rake and quadrant platform. This platform was similar to that of the improved self-rake, but the rake was a single attachment made to sweep the platform horizontally at regular intervals. Assigned to Seymour & Morgan, it entered into their system of self-rakes. The same month a patent was taken out by William H. Seymour, of the firm of Seymour & Morgan, for a machine differing little in essential principles from the above. The rake swept the platform every 14 feet, or at the will of the operator. This machine became very popular in the East and was known as the "New Yorker" self-rake (Pl. VI, fig. 1). Both these inventions entered into the system of self-rakes of Seymour & Morgan, and through this firm much was done toward perfecting this machine.

John H. Manny obtained a patent September 23, 1851, for hanging the cutter bar to the side of a triangular frame so that neither end could sag; also for a forker's stand back of the outer end of the platform. It had sickle-edged knives and the cutter could be raised or lowered at will. It could be used as a mower by detaching the platform, but was objected to as being too cumbersome. It was one of the earliest successful combined machines and laid the foundation of the reaper business of Rockford, Ill. R. T. Osgood obtained a patent February 17, 1852, for independent driving and supporting wheels on a common axle carrying a rectangular frame between them on the axle, also providing each drive wheel with ratchet wheel and pawl as used in the mowers of to-day. This was assigned to Cyrenus Wheeler, and, together with others, became one of the base patents of the "Cayuga Chief," a very popular machine of that day.

The next important invention* is that of Jearum Atkins, patented December 31, 1852. It was known as the Atkins Automaton from the action of the rake. This rake was rigged on a vertical post and had a jointed arm which swept across the platform gathering the grain against a shield; the post, rake, and shield then turned 90° on an axis, the rake raised and the grain dropped in the rear of the driving apparatus. It worked well for a time and had a large sale, but was finally abandoned.

In 1852 a man by the name of Hoffhein produced a rake that could operate as a reel—the early form of the revolving vane used on the reaper of to-day. The device consisted of a vertical shaft carrying

four reel arms so geared as to sweep the platform at regular intervals. The rakes were in pairs upon cross shafts and the latter were arranged to rock, so that when moving over the platform they would come close to it, but in the rest of the revolution they were high above the gearing.

September 20, 1853, Philo Sylla and Augustus Adams obtained a patent for a machine which carried three men upon the platform to bind the cut grain as it was forked or shoved around to them by a fourth man. An important feature of this machine was a finger bar hinged to the main frame so as to allow the bar to "vibrate perpendicularly and accommodate itself to uneven ground."

A. J. Cook, who had received a patent on a revolving reel rake in 1846, took out a patent March 28, 1854, for a reel rake sweeping backward, which was assigned to Cyrenus Wheeler. Abner Whitley, September 19, 1854, obtained a patent for suspending a rake to one of the reel blades, a very important patent.

In 1855, J. E. Newcomb obtained a patent for a dropper, which was assigned to J. F. Sieberling, of Ohio, the acknowledged head of the dropper system. The dropper as now used consists of an attachment behind the cutter bar, which holds the grain until enough has been accumulated for a sheaf, when it is lowered and the grain allowed to slide off. The first invention along this line was by Ogle (1822), who had some such arrangement on his machine (p. 15). Other devices have been used, such as one by Wheeler, in 1838, which delivered the grain by a canvas into a box, from which it was dropped (p. 29). The most improved form, however, consists of a number of slats fastened to the rear of the cutter bar, and which may be raised and lowered at the will of the operator. It is used to some extent at the present day, especially for particular purposes, as for bunching clover when cutting for seed.

In 1856 Owen Dorsey patented a self-rake which was an improvement on the Hoffhein type, and was an important patent in the development of this form of machine. It is operated much like the Hoffhein machine, having "rakes which rise and fall as they rotate, and as they approach the front part of the platform descend to the level of the latter and sweep over it, raking the cut grain therefrom, and then rise at the discharge end of the platform out of the way." At first the operator could not ride, but this difficulty was overcome by the patents of T. Whitenack, February 5, 1861, and of others. This is the first patented invention of revolving reels on a vertical axis, as the invention of Hoffhein was not patented. At this period there were a great number of devices using simply a single rake for sweeping the platform, but with the last-named invention the first types of the present self-rake made their appearance.

D. M. Osborne and W. A. Kirby, February 10, 1857, secured a patent covering a reel supported on a single post, a feature afterward incorporated in the Kirby, a popular machine of that day.

Both rigid-bar and flexible-bar machines now came into use, and especially among mowers were these distinctions important. There were the two divisions, the single-wheel rigid-bar type and the two-wheeled flexible machine. Reapers were also affected by changes in this line and were made like the mowers in both ways. A patent granted to Lewis Miller May 4, 1857, combined the reel with hinged platform, so as to preserve their relations on even ground, a very important invention. S. A. Lindsey took out a patent August 2, 1859, for a reel rake arranged to accommodate itself to a hinged platform, also covering the important combination of a quadrant platform, hinged finger beam, and frame supported by two wheels. The next year, September 18, McClintock Young obtained a patent for a "combination of a revolving reel shaft carrying diverging reel gatherers supported at one end only, the fixed double-walled cam and the rake revolving around said shaft and oscillating on an axis both eccentric and transverse to said shaft, with counterpoise to equalize the movement of said rake." The shaft of this was not vertical, but resembled that of the ordinary horizontal reel, and shows the manner of developing an important feature from the forms that preceded it. This invention is of special importance, as it was the foundation patent of the McCormick self-rake. The Whiteley patents, embodied in the Champion machine, were taken out at this date. In 1862 James S. Marsh took out a patent for a revolving rake and reel, the arms of which were hinged to the revolving wheel independent of each other. Finally, may be mentioned the patent of Samuel Johnson, February 7, 1865, for his celebrated reel rake, in which all the revolving arms carried rakes and were each hinged independently and all controlled by the operator. This was the Hoffhein type practically completed, and needed but detailed improvements to make the self-rake of to-day. With this patent the self-rake was virtually complete, and thereafter the many inventions referring to it were only in details. (See Pl. VI, fig. 2.) It had not long to remain king, however, for by 1870 the binder was coming into use, and the fate of the self-rake, except for particular places or purposes, was practically sealed.

HARVESTERS.

The term "harvester" may, in its broadest sense, be applied to the modern self-binder as well as to the header of the Western plains and of Australia. Long before the self-rake had reached perfection, invention had been going on in both these directions and various forms of machines had been devised. Even before a practical cutting apparatus had been produced efforts were being put forth toward making a device for heading and threshing grain, and also to discover some mode of forming the cut grain into sheaves.

BINDERS.

Taking up first the efforts made to construct a machine having an automatic binding apparatus, it is desirable that such machines be divided into two general classes: (1) Those in which the binding device is attached to a machine of the self-rake pattern, called the "low-down" class, and (2) those in which the grain is elevated to the binder, as in the present form of the machine.

Early devices for binding were very crude and differed greatly from the present form. Materials used for the band in these early forms were of three kinds—straw, wire, and twine—various attempts being made to use each of these materials. Many of the early devices, although automatic in the binding, required an attendant to furnish the power, while others required an attendant also in helping to bind.

The first attempt on record to bind grain by machinery was by John E. Heath, of Ohio, whose patent was granted July 22, 1850, and called for a twine or cord binder. His claims in patent specifications were: "First, gathering the grain and compressing it into a sheaf, substantially as herein set forth, by means of the rake and standard; second, carrying the cord around the sheaf and holding the latter until the band is tied by means of the curved lever *h* and toothed arm *g*, substantially as herein set forth; third, the employment of split thimble and sliding hook to aid in tying the band." Two more claims are mentioned, but they need not be noticed here. Little is known of this binder except from the patent. It was on the "low-down" principle, as were all the early machines and the rake mentioned in the first claim worked beneath the platform.¹

Two patents, one in 1851 by Watson, Renwick, and Watson, and one in 1853 by P. H. Watson and Renwick, foreshadowed the modern binder in great measure, but were too complicated to be practical or to allow of description here. The inventors were men well acquainted with patent-office methods and made the patent cover so many features that it was a stumbling block to later inventors. Their great complexity rendered the machines valueless, although showing considerable ingenuity. The latter of these machines approached more nearly to the modern binder than any of the early machines, the grain being carried by a series of revolving bands to a sort of crib, where it was bound automatically with cord. It, however, never got beyond the experimental form.

In 1853 J. E. Nesen patented a straw binder worked by an attendant, and Geo. Yost, in 1856, received a patent for a binder using cord cut into lengths for binding, which was also worked by an attendant.

The next device which need be noticed was invented by C. A. McPhitridge November 18, 1856, and was the first wire binder. The wire was coiled upon a reel and delivered to a reciprocating binding

¹ American Mechanical Dictionary, Vol. III.

FIG. 1.—THE MARSH HARVESTER (1866).

FIG. 2.—A SUCCESSFUL WIRE BINDER—LOCKE'S (1873).

arm, receiving the ordinary twist and cut of the later machines. During the year 1857 four patents were granted in this line, but all pertained to straw binding and were of little value.⁷

Now came an invention which in an indirect way was to revolutionize binder building. It was the invention of C. W. and W. W. Marsh, of Illinois, patented August 17, 1858, and was known as the Marsh harvester (Pl. VII, fig. 1). It had a frame much like that of the modern binder, with a canvas which elevated the grain over the drive wheel into a receiving box, and from which it was taken and bound by two men riding on the machine. This was not the first attempt at a harvester that carried men to do the binding, but the first that was practically successful. Augustus Adams and J. T. Gifford had built a machine in 1850 which delivered the grain by an endless canvas to two or more attendants who bound it into sheaves. It also had a box for receiving and carrying the sheaves until enough were collected for a shock. It was tried in the harvest of 1850 or 1851, but Mr. Gifford dying, Adams associated himself with another man, Philo Sylla, and began work on a machine of a different principle. The Marsh brothers were the first to deliver the grain by canvas over the drive wheel, and it was to this machine that the practical binders were afterwards attached.¹

The first Marsh harvester was built on the home farm in 1858. The next year 12 machines were built, but most of them failed by reason of poor construction, and not because of faulty principle. They kept at work, however, and in the winter of 1860-61 William W. Marsh and J. F. Hollister built a machine which was worked successfully for their harvests. Seeing the success of this machine, a company was formed, consisting of the two Marsh brothers, Mr. Hollister, and George Seward. They put out 24 machines in 1864, 26 in 1865, and 100 in 1866, the number increasing each year until 1870, when over 1,000 were built.⁷ Through the aid of William Deering, Lewis Steward, J. D. Easter, and E. H. Gammon, who early became connected with the firm, the business continued to grow, and from it has developed the Deering Harvester Company of to-day.

It was in building a machine to which the practical forms of binding device could be attached that the Marsh brothers established a landmark in the development of harvesting machinery, and made for themselves a name and reputation.

But while this framework of the modern binder was being developed, the binding apparatus was also being perfected, although attached almost without exception to machines of the self-rake type. Up to this time, however, nothing practical had been produced in the numerous attempts at straw, wire, and cord binding devices. Passing over several ingenious straw binders brought out in 1858 and 1859, we come to the patent of J. D. Osborn, June 14, 1859. This is shown by the

¹ Farm Implement News, May 18, 1893.

patent specifications to have had "a binding knot composed of three loops passed through each other," etc. The cord or twine was taken from a reel. Again omitting several unimportant devices we come to that of H. M. and W. W. Burson, patented June 26, 1860, which was a twine binder to be used upon any reaper, and which tied by means of hooks working together. It was not automatic. The next year the Bursons brought out a wire binder, which was the foundation of a machine that made a greater sensation and came nearer being a success than any of the "low-down" type, although the binder was worked by an attendant. The feeling against wire for binding was so strong that in 1865 he substituted a knotter for the wire-binding device, and had a twine binder at work in that year. But the price of twine, the necessity for a man to work the apparatus, and the influence of the Marsh harvester, then becoming so popular, doomed his machine to failure. After this nothing came of the "low-down" type of machine, and although many patents were taken out for binding devices, none became popular excepting those which were applied to the Marsh pattern.

The next important invention was that of Jacob Behel, patented February 16, 1864. It was the knotting bill which is used with little modification on almost all binders of the present day. Connected with the bill was a turning cord holder, consisting of a small notched wheel which held the cord. The bill seized the portions of the cord which were to form the knot, and looping it, moved past a knife which cut it off in the proper place, leaving the end of the cord from the ball firmly held by the turning wheel. Mr. Behel took out other patents, and by 1865 had a knotter which worked well.

May 31, 1870, a patent was taken out by George H. Spaulding for an improved grain binder of the Marsh harvester type. This machine contained the important feature of an automatic binding mechanism which made bundles of uniform size. The value of this invention was quickly recognized by manufacturers and incorporated in their machines.

The next name that should be noticed is that of Sylvanus D. Locke, who first took out a patent for an automatic binder in 1871. He took out various patents and made a fairly successful wire binder, which he finally attached to a harvester of the Marsh type through the aid of Walter A. Wood. This machine was first put out in 1873, and became a popular machine of that time (Pl. VII, fig. 2).

While Locke was perfecting his machine James F. and John H. Gordon, in connection with Mr. Deering, of the Marsh Harvester Company, were working on a machine, also of the wire-binding type. John H. Gordon produced his first "packer" binder in 1873, and his brother soon after brought out what was known as his "crane" wire binder, both machines becoming popular. These machines were put out by Gammon, Deering & Stewart and by D. M. Osborn & Co.,

while C. H. and L. J. McCormick soon began the manufacture of the Withington type of wire binder, one of the most successful wire binders ever put out. It differed from the Gordon and Locke machines in its chain movement, in having two spools of wire from which the bands were formed, and in other devices. All these were attached to the Marsh type of machines, and were fairly good machines. But about this time, when wire binders were becoming widely used, and when it seemed that these companies had the market in their power, the cord binder forged to the front and the wire binders were doomed to extinction.]

[Of the cord binders which had been devised up to 1875, when the wire binders were coming into wide use, several were valuable, but the one by Behel contained the principles that were to last. In 1875, however, John P. Appleby, who, as early as 1858, had invented a successful twine knoter, but who had since that time been devoting his time to wire binders, again turned his attention to cord machines. He connected himself with Parker & Stone, of Beloit, Wis., and with their aid built an automatic binder that promised well. It was the foundation of the binding apparatus which is used on almost every binder to-day. It combined the good points of the preceding inventions in a great degree, with some principles original with the inventor. It underwent improvements during 1876 and 1877, and through the aid of William Deering was still further perfected during the two following years. By 1880 it was practically perfected, and 3,000 were put upon the market.] The Deering, McCormick, Champion, and Osborn companies at once procured rights and began the manufacture of this type of binder in combination with the Marsh style of frame, adding various improvements in details as they saw fit. This style of machine immediately leaped into popular favor. All others were soon distanced in the race for superiority, and the binders of the present are simply this type of machine more nearly perfected. From that day the modifications have been in detail and not in principle. It is true that among the twenty-odd manufacturers of machines there are found types differing considerably from this, but they are not among the most popular machines. 9)

HEADERS.

The first attempts at a reaping machine were probably in the form of a header. In regard to the first historical account we know this to be true, for Pliny describes one at work (p. 12) in the fields of Gaul, which was of this type. It is probable, too, that some forms of the harvester were in use by the ancients, of which we have no record, since historians gave their attention to other than agricultural subjects. The earliest English machines were also after the form of the old Gallic stripper, so that this mode of harvesting is not new. In America various attempts have been made to construct heading machines, the

trials reaching back to the earliest inventions in reaping machinery, while from the very first, attempts were made to build a threshing apparatus in connection.

As early as 1828, Samuel Lane, of Maine, obtained a patent for a machine which was a combined harvester and thresher, a very ingenious but complex machine. It never went beyond a patent, however. Various other machines were constructed, seeking to combine the reaper and thresher, a few of which may be mentioned.

A machine for harvesting, threshing, cleaning, and bagging grain was patented June 28, 1836, by H. Moore and J. Hascall, which contained many ingenious devices and might have proved a success, with some improvements, had the great fields of the Western plains and California been developed at that time. In the climate of the more eastern States it was impractical and never became a success.

In 1845 an Englishman by the name of Ridley, then residing in Australia, invented a combined harvester and thresher which excited much comment at the time. It was made to be pushed before the horses and the heads were torn off by a comb-like device much after the style of the ancient machine of Gaul. The climate of that country being favorable for the use of such machines it was used to a considerable extent. Perfected types of the combined harvester and thresher are used to a considerable extent in Australia to-day.

On October 2, 1848, George Esterly, of Wisconsin, patented a harvester which was a noted machine in that day. It had a reel which severed the heads by striking the straw against a knife on the front of the machine. The heads were collected in a box on the back part of the machine just in front of the horses, which were hitched in the rear.

The next and most important invention was that of Jonathan Haines, of Illinois, patented March 27, 1849, and known throughout the West as "Haines's Illinois Harvester." As improved, it was a thoroughly practical header and large numbers of them have been sold. It had a device for raising and lowering the cutters, and cut a very wide swath. It is this style of machine that is now used in great numbers on the plains of the West. This machine (Pl. VIII, fig. 1) is fitted with a very long cutter-bar and reel, and by means of a long, canvas elevator carries the heads to one side, where they are deposited in a wagon with a bed fitted for the purpose. It is pushed by attaching four horses abreast to the tongue in the rear, and guided by a wheel-steering device. Six men and ten horses can by the aid of this machine cut and stack from 15 to 30 acres per day.

In some parts of the West, especially in California, where there is no fear of rain during harvest, a combined harvester and thresher is used, which heads, threshes, separates, and sacks the grain (Pl. VIII, fig. 2). It is propelled either by a traction engine or by horses. If horses are used, from 30 to 36 are required, and if steam is used more

FIG. 1.—A MODERN HEADER.

FIG. 2.—THE COMBINED HARVESTER AND THRESHER.

men are needed than if horses furnish the power. The machine has a capacity of from 60 to 125 acres per day or from 1,700 to 3,000 bushels. These machines have done a great deal toward developing the immense wheat output of the Western country and should hold no small place among the harvesting appliances of the present day.

American harvesting machines are the most perfect in the world, and to-day they are being introduced into almost every country on the globe. In 1840, 3 reapers were made in America; in 1845, 500 were made and 50 people were employed; in 1850, 3,000 were put out; in 1860, 20,000 were turned out by factories employing 2,000 hands. During the next ten years the increase was not so rapid, but in 1870 30,000 were built by 5,000 employees; in 1880, 60,000 machines were built by 20,000 employees. In 1885, 1,000 binders and 150,000 reapers and mowers were constructed by 30,000 employees. In 1890 two manufacturing establishments in Chicago made more than 200,000 machines, half of which were binders and the other half reapers and mowers, and in 1899 more than one single firm exceeded that number.

MOWERS.

In the early development of the mower, it was so intimately connected with the reaper that a little space should here be devoted to a short review of its history. Hussey's first machine was really a mower, and it was upon this principle that the mower was afterwards built. Many of the early machines contained combinations of the mower and reaper, and were used with a little adjustment to cut either grain or grass.

The idea of a separate machine for cutting grass was conceived in America, the first attempt to construct such a machine being by Peter Gaillard, of Pennsylvania, whose patent was dated December 4, 1812. The machine was not successful, however, and it is remarkable only as being the first. The next was by Jeremiah Bailey, February 13, 1822 (see page 23), and was on the revolving-cutter plan. It gained some notoriety at the time, and worked with a slight degree of success. Another important invention was that of Wm. Manning, patented May 3, 1831 (see page 23). It was really a reaping machine, but contained the principle of the reciprocating knife which afterwards became so famous as the basis for all mower cutters.

This brings us to the celebrated patent of Hussey in 1833, the foundation of the modern mower. Hussey's combination of the reciprocating knife and slotted guards is used with some improvements upon all mowers of the present day. Hussey brought out the principle: others helped to perfect it. The history of the mower from 1833 to the present day has been simply a perfecting of this type of cutter bar, and the working out of certain necessary details.

In this development there were two classes of machines: (1) Those having a rigid bar and single drive wheel, and later, (2) those having

the double drive wheel and flexible bar. In the first type there was sometimes a smaller wheel to support the cutter bar, and sometimes none; while in the latter the cutter bar was jointed to the machine, and had, if any, only a small roller at the end.

A name that stands out prominently in the development of mowers is that of William F. Ketchum, who has sometimes been spoken of as the father of the mower trade, since he was the first to put mowers on the market as a type of machine distinct from the reaper (Pl. IX, fig. 1). He took out several patents, but the one granted July 10, 1847, was of especial importance. The main features of this patent were the unobstructed space left between the driving wheel and the finger bar with its support, and the remarkable simplicity of the machine. The cutter was an endless chain of knives, which never became successful, but which caused some excitement at the time. Ketchum afterwards adopted the Hussey type of cutter and produced a very successful mower of the rigid-bar type. It was this machine that led the way in mower development and became the first really practical machine.

In 1850 Ebenezer Danford, of Illinois, patented a machine with a double knife cutter, previously described (p. 31). This was a strong machine and one of the most successful up to this time. By 1855 this type of the fixed-bar machine had been perfected, but it lay with the flexible-bar machines, which were now coming into use, to sweep from the market the former type.

The first invention showing the feature of a flexible bar was that of Hazard Knowles, the machinist of the Patent Office at Washington. It showed many valuable features of a reaping machine also, but no patent was taken out. The patent granted to Cyrenus Wheeler, December 5, 1854, marks the division between the two types of machines. Wheeler was a practical man, and, like McCormick in the development of the reaper, succeeded in combining so many important features in his machines as to give him a place as one of the foremost pioneers in the development of the mower. The machine of 1854 was not a success as constructed, but the features of two drive wheels and a cutter bar joined to the main wheels were lasting.

A careful study of the reports of some of the mower trials which were held about this time would be of use in showing what machines were then in use and to what degree they were practical. At a trial of mowers and reapers at Springfield, Ohio, July, 1852, three combined machines and three mowers were entered. The combined types were by McCormick, Purviance, and Smith, and the mowers by Hussey, Castle, and Ketchum. McCormick's mower was simply the reaper with platform removed and with the cutter set low. It did not operate well, however. Purviance's mower was also the reaper with platform removed and cutters lowered. The alteration was easily made and the machine operated quite well, but the committee gave as its

FIG. 1.—KETCHUM'S MOWER (1847).

FIG. 2.—LEWIS MILLER'S MOWER (1858).

opinion that combined machines were not so good as the separate types. This was undoubtedly correct, for the combined machines soon dropped out of view on the appearance of the mower.

Smith's combined machine was the third mower and reaper exhibited at the above-named trial, but it failed to do good work. As to the mowers shown, Hussey's was quite simple and operated well, but required three or four horses. Castle's, a creditable machine, with a reel and two series of knives, worked somewhat like Bell's old English type. The committee expressed itself as doubtful as to its operating when the knives became dull. Ketchum's was the simplest and most durable in construction and quite light in draft. It took the first prize, with the Hussey machine second. The report shows that Ketchum had a very practical machine in 1852, with Hussey a close second.¹

Another trial at Geneva, N. Y., about the same time, shows Manny's, Ketchum's, McCormick's, Murray's, Rugg's and Danford's machines among the contestants. Manny's had a peculiarly constructed frame, and the knife could be regulated while the machine was in motion. A reel was used, and the cutter sections showed the early efforts to prevent clogging by placing the back part of the edge of each knife in contact with the guard, a modification of the Hussey cutter. Ketchum's had a simple compact construction, with an iron elbow connecting the cutter bar with the running parts of the machine. It was the same style of machine as exhibited in the trial at Springfield. McCormick's machine had obtuse sickle-edged sections and also the form of spear-shaped fingers patented in 1847. The machine was too frail, and the knives could not stand the strain. Rugg's resembled the old Bell machine, having the horses in the rear. It had a means of raising and lowering the cutters at will, but soon ceased to operate. Danford's was also used as a reaper, and had a double crank with blades reciprocating past each other. Hussey, McCormick, Cook, and Burrall exhibited combined machines.

At a trial in 1855 at Flushing, N. Y., there were five entries, Manny taking first and Ketchum second prize. At a contest two years later there were five entries—Wood's, Ketchum's, Allen's, Bartlow's, and Harmon's. Ketchum took first and Allen second prize. At the trial at Geneva in 1866, twenty different mowers were entered, so that it is seen that an immense amount of work had been done on this machine, and from the great number in competition it is evident that the successful mower had been developed.²

Returning to the history, however, we find that in 1855 a patent was granted to Jonathan Haines which was very important in the development of the flexible cutter bar. It had two drive wheels and

¹ Report of Board Agriculture of Ohio, 1852, p. 120.

² Transactions New York Agricultural Society, 1852, 1855, 1857, 1860, 1866.

a cutter bar jointed to the main frame in such a manner that it could be lifted over obstructions, and the tongue was rigidly fastened to the main frame.

On July 17, 1856, a patent was granted to Cornelius Aultman and Lewis Miller containing principles that still exist in all successful mowers. The first patent claimed "connecting the cutter bar to the machine by the double-rule joint or the double-jointed coupling pin." It was reissued to cover an arrangement for holding up the bar while moving, and the combination of ratchet wheel, pawl, and spring. On May 4, 1858, Lewis Miller took out a patent on a mower that combined the features of the former machine with some new principles. (Pl. IX, fig. 2.) It contained all the elements of the successful modern two-wheeled machine, and mower development since that time has been a perfecting of this type. This machine was built under the name of the "Buckeye," and, with a substitution of metal for certain wooden parts, and certain other improvements, it is in use to-day. E. Ball, associated with this firm, also made valuable improvements in mowers. In 1856 a patent was granted to A. Kirby, covering improvement made by him a few years previous, and his machines soon became popular. Others took up the manufacture of mowers at this early date, so that by 1860 the mower had become a thoroughly practical machine, and was being improved by various firms throughout the country. This improvement has gone on with the many makes of machines now in existence, and to-day we have various forms, from the single one-horse machine to the large two-horse type, with its long cutter bar, running with as light a draft as the former clumsy machine did with a cut but half as wide. As a result of this development the amount of hay produced in the United States has increased enormously, and to-day it stands as one of the most important crops.

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