Historical Highlights in Sugar Beet Harvest Mechanization

AUSTIN A. ARMER[1]

Received for publication June 8, 1964

The word "Historical" in the title refers to rather recent chronology—limited mainly to personal experiences of the author over the past 25 years, together with some study of the previous art as far back as 1913.

The mechanical harvest of sugar beets is, for the purpose of this account, divided into three operations; topping, digging and cleaning. In machines currently in use, these operations are more or less combined. Hence a presentation of the genesis of a few of the leading U. S. makes of commercial harvesting machines will conclude the account.

Topping

In 1913, The Great Western Sugar Company of Denver, Colorado, offered a substantial cash prize for a successful beet harvester. In response to this offer, over 50 machines were submitted, and 15 of these were fieldworthy enough for testing and appraisal. These machines demonstrated about every combination of elements which has subsequently come into use. Following is a tabular outline of inventors, topping systems, and subsequent applications as of 1913.

Inventor, 1913	System	Subsequent application
1. Arthur	Multiple disk roll finder narrow knife	Several contemporary English harvesters
2. Atwood	Roll finder-fixed narrow knife	Lockwood Topper-Windrower (Present)
3. Blevins & Lewis	Multiple finger finder fixed narrow knife	Armer experiments 1940-43
4. Crume	Multiple disk roll finder	See Item 1
5. Dawson	Flat Shoe finder, variable ratio. Knife splits crown	Most contemporary U.S. disk toppers & scalpers Roscoe Zuckerman 1943
6. Geibig	Flat shoe finder Rotary blade cutter	See Item 5
7. Leyner	Multiple disk finder 2 flat cutting disks	Catchpole (England)
8. Murphy	Driven roll finder	Devey, 1939, Armer (U.C.) 1940
	Oscillating knife	Powers (U.C.) 1939

[1] Agricultural Engineer. Spreckels Sugar Company, Woodland, California.

Inventor, 1913	System	Subsequent application
9. Pruvot, France	Driven roll finder fixed narrow knife	Lockwood, Wescon and Speedy Topper-Windrowers
10. Siedersleben, Germany	Multiple finger finder Concave topping disk	Armer (U.C.) 1941 Present Farmhand, John Deere Gemco, International
11. Smith	Multiple disk finder Stationary narrow knife	Several contemporary English harvesters

Topping in the Machine

While ground topping offers some self-evident advantages, topping in the machine has certain unique virtues. These include:

1) All operations (digging, topping, loading) can be done in a single pass down the row.
2) Higher speeds are possible than with ground toppers.
3) Operation is possible in mud or peat, where beets are insecure in the soil.

Some contemporary harvesters which top in the machine are Armer (Ireland), Marbeet and Scott-Viner. Each of these makes use of a pair of counter-rotating disks, with slightly overlapping cutting edges.

Ground Topping

Ground, or "In Place" topping has long appealed to harvester designers, mainly for these reasons:

1) The beets are rigidly fixed in the ground.
2) The beets are approximately uniform in lateral positioning.
3) The beets, while not uniform in height at the crown, can be gaged by a "Finder" which adjusts the vertical position of cut.
4) Topping and top saving may be a separate operation from root lifting and loading.

From 1938 to 1945, a comprehensive program of research and development in sugar beet field machinery was pursued at the University of California at Davis. The department of Agricultural Engineering supplied shop, field and laboratory facilities in addition to a highly trained staff. The U. S. Department of Agriculture participated, and the project was financed through a grant from the U. S. Beet Sugar Association. The late Prof. H. B. Walker headed the project.

Several "In Place" toppers were developed by the project, and demonstrated a remarkable facility for accurately severing

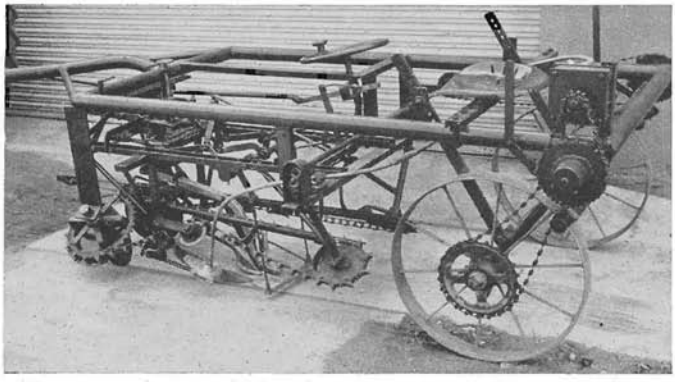

Figure 1.—In 1939, John Powers, University of California, Davis, designed this oscillating knife, variable-cut topper.

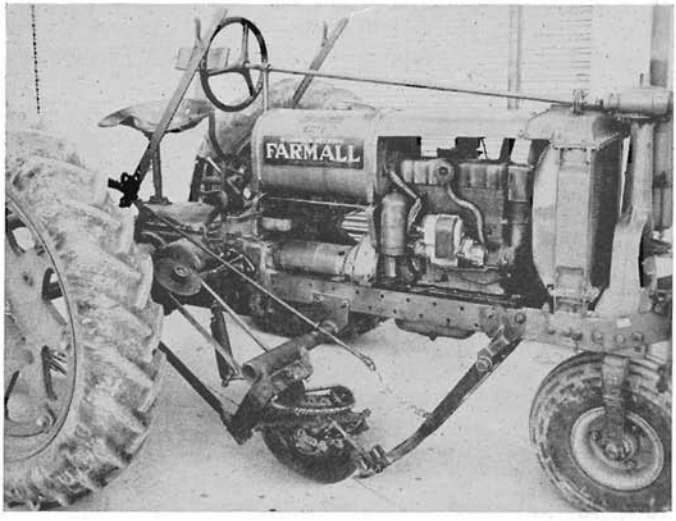

Figure 2.—In 1940, Austin Armer, University of California, redesigned the Devey disc topper for greater simplicity and higher operating speed.

the foliage while the roots remained intact in the soil (Figures 1 and 2).

An entirely different topping principle involves the attrition of the foliage—chopping the leaves and petioles into bits with a beating or scrubbing device which is not quite severe enough to damage the root crown. The first of the "Scrubbing Brush" toppers known to this author was the rotary brush preceding the lifter blades of the Murphy Digger, one of the entrants in

The Great Western Sugar Company harvest competition in 1913 (Figure 3).

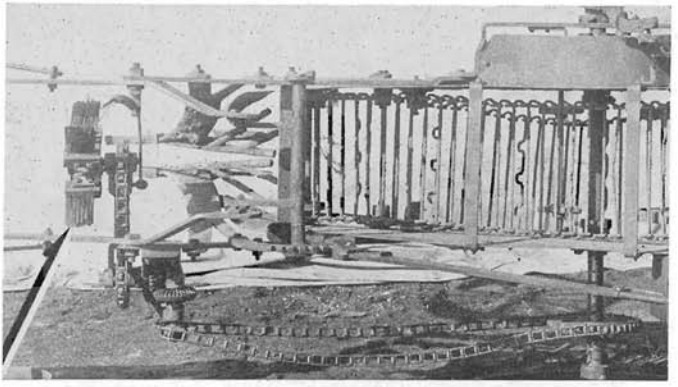

Figure 3.—The Murphy Digger (1939) was a modified potato digger with a rotary brush topper.

A much more effective rotary brush was used in an experimental harvester built by Roscoe Zuckerman of Stockton, California in 1943 (Figure 4). It worked satisfactorily in flat-planted beets is light soils, but the machine never became operational on a commercial scale.

Figure 4.—Roscoe Zuckerman (1943) built a beet harvester using a rotary brush topper.

Perhaps the most important contribution to "Attrition Topping" was the experimental work performed in the mid-30's by

Mr. Jonathan Garst. This led to his granting an exclusive license to Olsen Manufacturing Company of Boise, Idaho. Their rubber flail beater became well known by its trade name "Rotobeater" (Figure 5).

Figure 5.—The Olson Rotobeater was built under license from Jonathan Garst, inventor and patentee, in 1944.

Saving Tops for Feed

There have been numberless well-planned experiments performed, all of which demonstrated the feed value of beet tops, whether fed green-chopped, ensiled, dehydrated, baled or (most recently) wafered.

In 1948, Spreckels Sugar Company cooperated in a large-scale demonstration of the value of beet foliage when steam-blanched, pressed to remove juices containing soluble salts, and dried into a meal closely resembling alfalfa meal. A Blackwelder-Locke green crop harvester was employed to cut and deliver clean foliage prior to harvesting the roots. During the same series of trials, Blackwelder Manufacturing Company built an experimental rotary chopper which blew the chopped leaves into a truck.

In 1952, Spreckels Sugar Company conducted trials which involved kiln-drying of chopped beet tops. An excellent, nutritious meal was produced, but fuel costs proved to be prohibitive. In 1956, the Company conducted experiments to show how, with proper precautions, palatable silage could be made from beet tops. In both of these trials, chopped beet foliage was delivered by an experimental Rotobeater supplied by Olson Manufacturing Company.

The most recent efforts to harvest and utilize beet tops have made use of the Lockwood, Speedy and Wescon toppers (Figure 6).

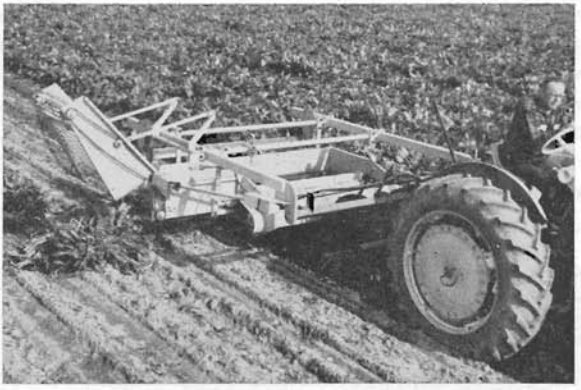

Figure 6.—The Wescon topper, like the Lockwood and Speedy, delivers multiple windrows of beet tops (1964).

Digging

The presence of soil with the beets as they are dug has long been a source of concern to inventors of beet harvesting machinery. The earlier attempts at mechanical beet harvesting were mainly attempts to adapt potato harvesters to the beet field (Figure 3).

Horse-drawn potato diggers appeared in great variety during the second half of the 19th century. Most of these devices contemplated some means of sifting loose soil from the potatoes ("Potato Chain" is a heritage of this era). Such a procedure worked with potatoes, which are rarely grown in heavy cloddy soil, and which have no hair roots by which soil adheres.

A potato digger patented in 1872 in the United States by a Canadian inventor held the germ of a successful beet digger, but the patent evidently escaped notice until a search was made in 1949 to determine the patentability of a digger invented by Carl Oppel, then residing in Alberta, Canada (Figure 7).

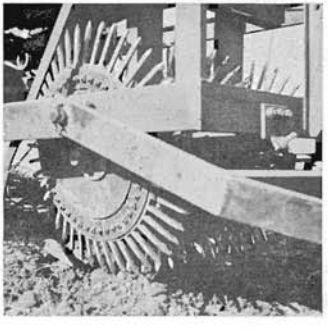

Figure 7.—Carl Oppel initiated the large-scale application of the finger-wheel lifter principle in 1949.

Meanwhile, the same principle had been invented and reduced to practice by Mr. Robert Maynard, an implement maker at Whittlesford, near Cambridge, England in 1923 or 1924, and sold in considerable numbers for digging sugar beets, particularly in England's fen soils (Figure 8). Quite independently, Hammer Brothers of Ohio developed lifter wheels of the finger type (Figure 9).

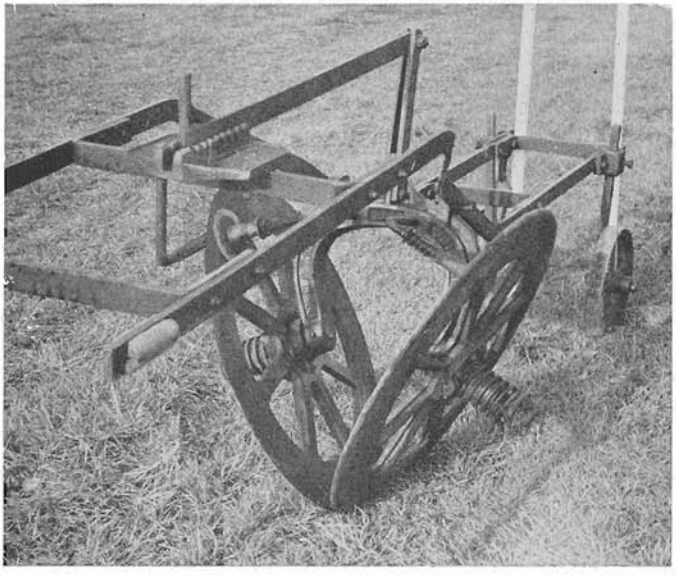

Figure 8.—Mr. Robert Maynard (1923) built this horse-drawn wheel type lifter (Photo courtesy British Sugar Corporation, Ltd.).

Figure 9. — Hammer Brothers of Ohio built beet harvesters using the finger-wheel digger (Photographed in 1932 by E. M. Mervine).

There is no evidence that recent U. S. inventors of beet harvesters were aware of either "Maynard Wheels" or the 1872 potato digger wheels. Necessity is the mother of invention, and

the necessity to free sugar beets from soil existed in full measure as an obstacle to developing a successful sugar beet harvester.

The "Colorado Lifter," or double blade plow was an effective beet digger in friable soils. Most of the earlier sugar beet harvesting machines employed double-blade plows. (The origin of the double blade is obscure—it probably came to this country from Germany as the horse drawn "Bow Plow").

Beet harvesters built commercially in the United States at this time favor the wheel type lifter. This preference is probably based on the lower draft of the wheel lifter as compared to the double point lifter. But the wheel lifter comes to grief in heavy, dry soils. Its sharp rims slice through the crust, lifting out a ribbon of soil which contains the beets. This ribbon then cracks apart at each beet, forming large solid chunks, almost impossible to break up or separate in any subsequent screening operation.

Cleaning

In the days of horsedrawn farm implements, the potato digger represented the last word in root harvesting devices. It is no wonder, therefore, that when inventors turned their attention to harvesting sugar beets, they first attempted minor modifications to the potato digger.

These modified potato diggers worked almost as well with sugar beets as they did with potatoes; what most people failed to realize was that the potatoes, after being dug, were dropped back onto the ground and later picked up—one at a time—by hand.

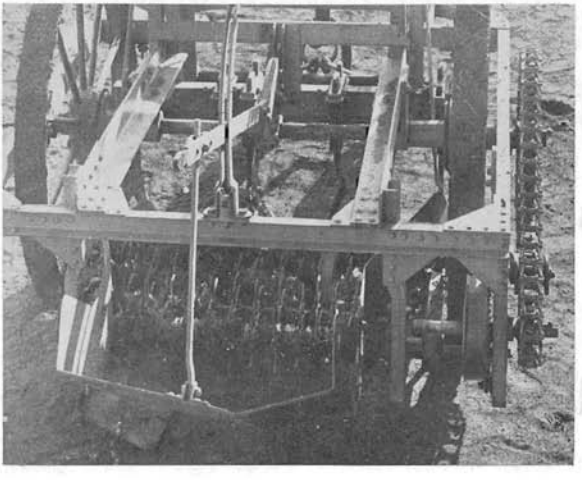

Figure 10.—The Pruvot digger (1913) used a transverse multiple shaft cleaning screen — the first known application of "Star Wheels."

Thus the need became apparent for a mechanism more effective in breaking clods by impact than was possible with potato diggers. Such a mechanism was applied to the Pruvot digger built by Emile Degremont at Le Cateau, France, in 1913 (Figure 10). This digger replaced potato chain with a series of four transverse rotating shafts to which were fastened a series of "Star Wheels." These wheels behaved like 6-lobed cams, so that beets and clods were "kicked" from wheel to wheel. Thus beets and clods were subjected to both propulsion and violent agitation, with the result that many clods were fractured and sifted out, while beets survived with only minor bruises.

The Pruvot digger was entered in The Great Western Sugar Company harvester competition in 1913, and (along with the Provot topper) worked so well that The Great Western Sugar Company continued to improve and perfect it. In 1924, their chief engineer, Mr. George Rienks, Sr., revived and improved the Pruvot "Star Wheels," and developed the famous "Rienks Screen"- a beet cleaning device used in most receiving stations until recently, and still used in most makes of sugar beet harvester (Figure 11).

Figure 11.—The now famous Rienks Screen was developed by Mr. George Rienks, Sr., based on the star wheel principle.

Hand Sorting

While beet diggers equipped with Rienks screens delivered clean beets grown in light soils, the beets from California's fertile but fractious adobe were generally accompanied by numerous large, hard clods. To separate these clods from the beets, Prof. Roy Bainer (Agricultural Engineering Department Head, University of California, Davis) suggested passing beets and clods over a "picking table," where clods could be manually picked out of the beets. Acting on this suggestion, Austin Armer designed two successive models of harvesters employing sorting belts

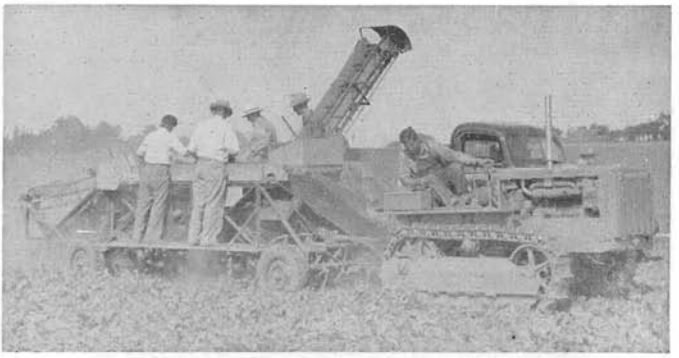

Figure 12.—In 1941 Austin Armer, University of California, developed this two row beet harvester, using the hand-sorting principle suggested by Prof. Roy Bainer.

which travelled at half ground speed. This slow belt speed gave enough time for unskilled labor to make the separation (Figure 12). Experience proved that even when newly dug beets travelled over a Rienks screen, they were accompanied by so many clods that it was easier to pick beets from clods than clods from beets.

The hand sorting principle was pursued further; Armer designed a hand-sorting revolving turntable as an attachment to a John Deere No. 53 harvester at Fort Collins, Colorado, in 1942 (Figure 13).. When the John Deere No. 100 beet harvester was introduced, it was furnished with a similar turntable adaptable either to removing clods from beets or vice versa (Figure 14).

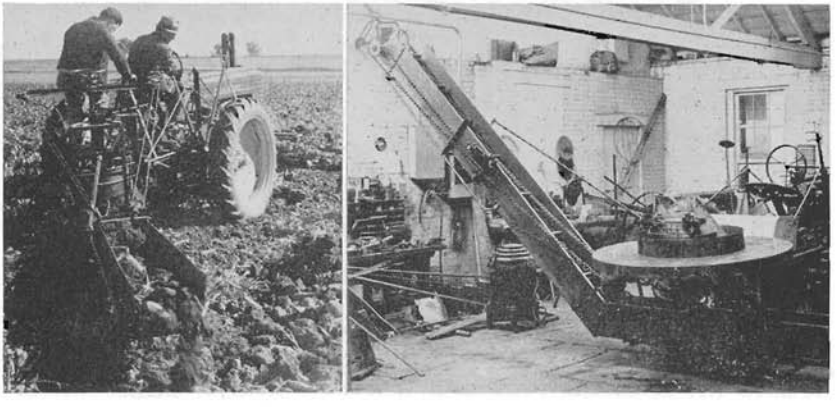

Figure 13.—In 1942 Armer applied the hand-sorting principle (turntable) to the John Deere No. 53 beet harvester.

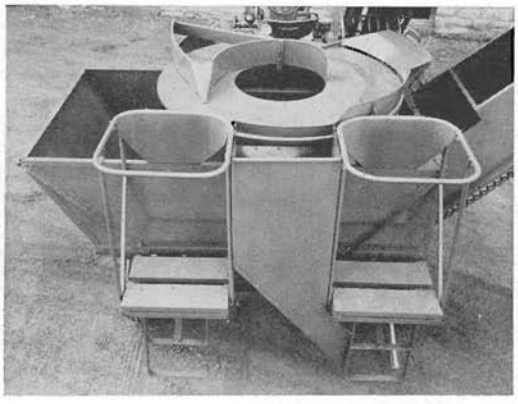

Figure 14.—The John Deere No. 100 beet harvester (1943) provided an optional hand-sorting turntable.

The John Deere No. 200 beet harvester (Figure 15) used a sorting belt (potato chain) arranged similarly to that on Armer's 1941 harvester at Davis. Likewise, the International Model HMI harvester had an optional sorting belt.

Figure 15.—The John Deere No. 200 beet harvester (1951) used sorting belts, similar to Armer's 1941 experimental machine.

When Marbeet harvesters came into extensive use in 1945, the clod problem was reduced, and hand sorting was eliminated. However, the clod and trash problem was then passed from the field to the receiving station, and more effective means for separation at the receiving stations became a major development project.

Commercial Machines in Current Use

In the United States (1964) sugar beet harvesting machinery is offered by an impressive list of manufacturers. The names presented herewith are known to the author; others may be available.

Blackwelder Manufacturing Company ("Marbeet")
Deere and Company
Farmhand Division of Daffin Corporation
International Harvester Company ("McCormick")
Interstate Manufacturing Company ("Imco")
Krier Engineering and Sales
Lockwood Grader Corporation (Toppers)
McCallum Manufacturing Company
Parma Incorporated
Speedy Manufacturing Company (Toppers)
Western Conveyor Company ("Wescon")

This list of a dozen manufacturers embraces at least twice that number of machine models, so that a somewhat bewildering choice is presented to a prospective purchaser.

However, the ancestors of this big family were few in number.

Only one make (Marbeet) represents an unbroken line of descent from its prototype—the experimental spike-wheel harvester built by Lloyd and Lewis Schmidt in 1941 (Figure 16); financed by A. L. Jongeneel; christened "Marion Beet Wheel" in honor of Mrs. Marion Jongeneel, and finally contracted to "Marbeet" (Figures 17, 18, 19, 20).

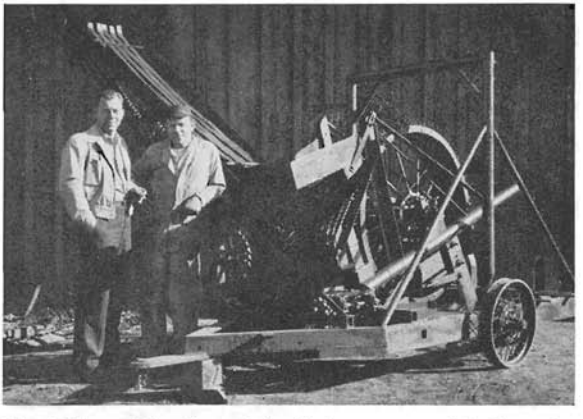

Figure 16.—The original model of the present Marbeet harvesters was built by Lewis and Lloyd Schmidt in 1942.

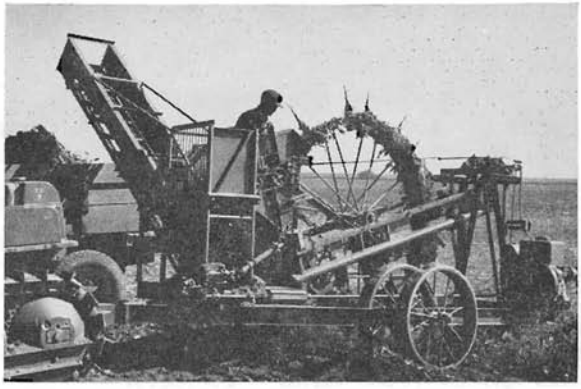

Figure 17.—The first commercially produced Marbeet harvester (1943).

Figure 18.—The first two-row Marbeet (1944).

Figure 19.—The Marbeet "Midget" (1950).

Figure 20.—The Marbeet "Twin Row" (1962).

All others in this list, except those making toppers only, offer harvesters which are related by blood or marriage to the Keist harvester (1942-48, Figure 21) and the lifter wheels of Carl Oppel (Figures 7 and 22).

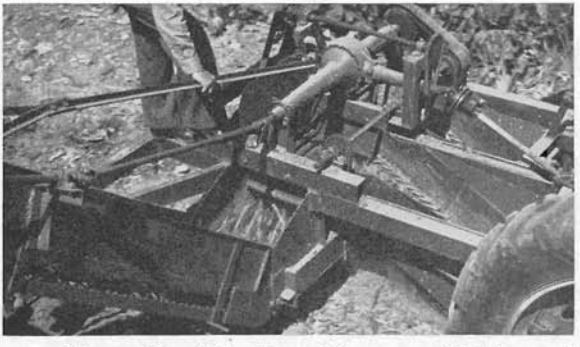

Figure 21.—The Keist Harvester (1944).

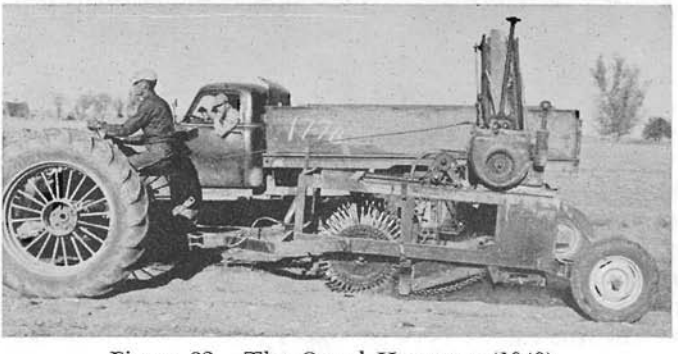

Figure 22.—The Oppel Harvester (1949).

All of the rotary flail toppers have a common ancestor—Jonathan Garst's patented beater of the late 1930's. Those with driven-wheel finders actuating fixed slanting knives are reminiscent of the Pruvot topper of 1913 (Figure 23), although this machine was in all probability unknown to the present generation of topper designers.

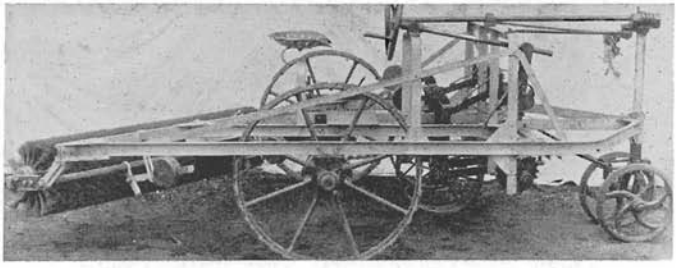

Figure 23.—The Pruvot Topper (1913).

The many rotating disk toppers bear a close resemblance to the experimental toppers of Devey and Armer (Figures 24 and 2). Here again is, in all probability, an example of independent development which led to devices closely resembling earlier models, yet not directly descended from them.

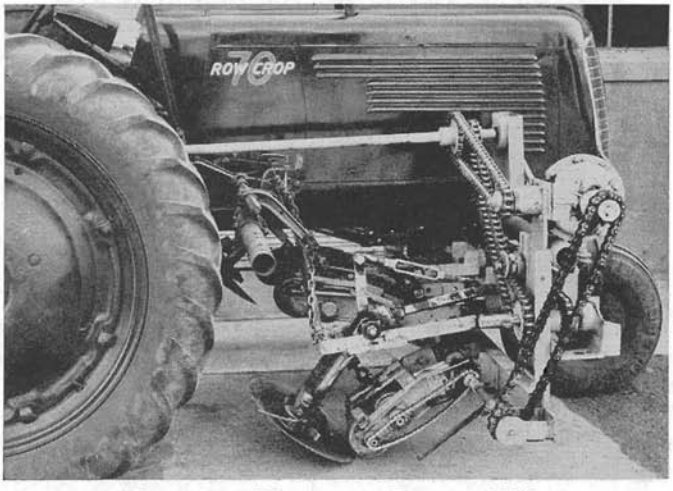

Figure 24.—The Devey Topper (1939).

These examples of recurring ideas, closely similar yet independently arrived at, suggest that evolution in sugar beet harvesting machinery parallels evolution in nature. Environment (in this case the character of the sugar beet field in relation to its harvest) is the basic determinant of an organism capable of survival (in this case, a beet harvester).