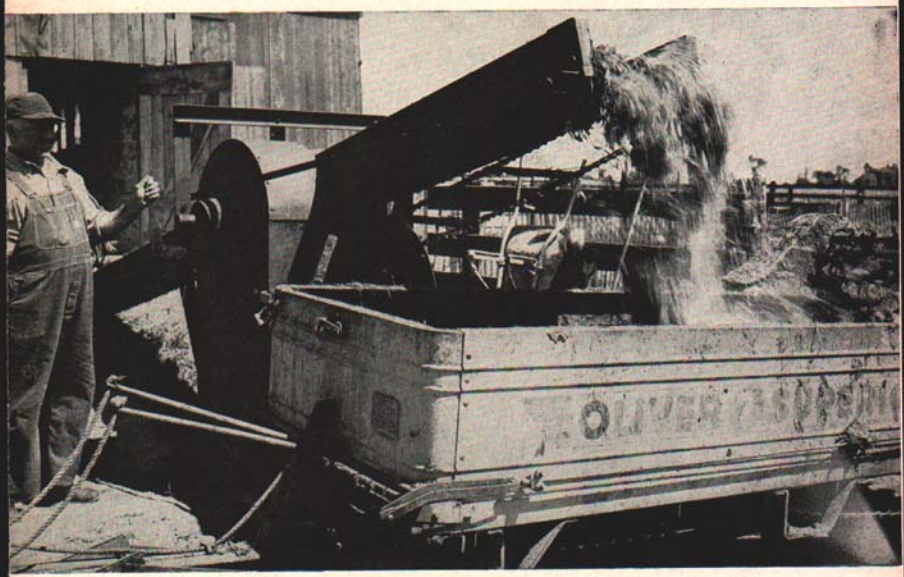
EXTENSION BULLETIN 265

MECHANICAL BARN CLEANERS

By ROBERT L. MADDEX and ARTHUR W. FARRALL



MICHIGAN STATE COLLEGE
COOPERATIVE EXTENSION SERVICE
EAST LANSING

Issued as "Mechanical Gutter Cleaners," October 1944
First Revision, issued as "Mechanical Barn Cleaners," February 1948
Second Revision, April 1951

CONTENTS

SUMMARY

1. Several types of barn cleaners are available. The principal ones are as follows:

(a) The windup type used mostly on barns with a single gutter. (b) The endless chain type used mostly in barns with two gutters. (c) The oscillating conveyor type used on either a single or double gutter barn. (d) The endless rubber belt type used on either single or double gutter barns. (e) The claw or scraper type which is used principally on single gutter barns.

2. Gutter cleaners require sturdy construction and careful selection of material.

3. Present cleaners are relatively expensive to construct and install, but are very inexpensive to operate. They do a very satisfactory job.

4. The cost of gutter cleaners may not be justified economically for small herds, but may be desirable from the standpoint of eliminating much of the disagreeable work of barn cleaning.

5. It is important that a barn cleaner be used which cleans out thoroughly and does not leave deep pockets of material to cause odors. Some designs are better than others in this respect.

6. Accurate tests have shown that the cost of operating a mechanical barn cleaner on a typical setup caring for 35 cows is only about 80 kwh per year which is a very moderate figure.

7. Experience has shown that much of the success with a mechanical barn cleaner depends upon having the equipment properly installed. It usually pays to have an experienced mechanic install the unit.

Mechanical Barn Cleaners[1]

By ROBERT L. MADDEX[2] and ARTHUR W. FARRALL[3]

The present high cost and scarcity of farm labor have caused many farmers to turn to mechanization as an aid and solution to their help problem. Mechanization of most of the major farm crops has resulted in remarkable labor-saving developments.

The livestock industry and, particularly, the dairy business have always required much hand labor for such jobs as milking, cleaning the barn, preparing feed and the like. One of the most disagreeable of these jobs is that of cleaning the barn.

The advent of electric power on farms has brought with it the possibility of using electric energy to do many of these chores and tasks. Electrically operated barn gutter cleaners have been developed and have proved to be practical and efficient. Several were described by Witz and Bell in a previous edition of this bulletin, published in October 1944. Much progress has been made since then, and more valuable information has been collected which makes possible a more up-to-date publication on the subject.

RECENT DEVELOPMENTS

Since the first commercially manufactured barn cleaners were brought out in the 1940's, there have been a number of new and promising designs placed on the market. Some of these use an oscillating carrier and some make use of a special type of rubber belt.

Experience has shown that some of the older designs were very unsanitary on account of pockets which did not clean out. Some of the newer designs have eliminated this difficulty.

Barn cleaners in general may be said to be still somewhat in the development stage; however, many of them are now being used satisfactorily and those which have been built have pointed the way toward

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improvements which now make it possible to purchase a reasonably, dependable cleaner from several different companies.

Experience has shown that many of the troubles encountered in the early days of the barn cleaner were due to one or more of the following causes which in reality could be summarized as poor installation.

1. Gutters too rough.
2. Corners of gutters and turning points for chains improperly made or not sufficiently strong.
3. Overloading in cold weather.
4. Improper chain tension.
5. Chains installed upside down.
6. Improperly trained mechanics used to install the unit.

The mechanical barn cleaner has now reached the stage where its performance can be depended upon and on dozens of farms it has shown itself to be a great labor and money saver, as well as being a means of eliminating one of the disagreeable farm jobs.

Careful tests run during the year 1949-50 on the George Kelting Farm of Dowling, Michigan showed that with a herd of 35 cows the barn cleaner moved and unloaded 212 tons of manure during the year with a total electrical energy consumption of 82 kwh, which cost $1.61 for the year's operation. This compares very favorably with costs determined in 1947 and reported in the first revision of this bulletin. Consequently, those costs are retained in this revision. (See pages 21-23.)

DESCRIPTION OF CLEANERS

The two principal types of electric barn cleaners are: The wind-up type which has a separate apron for each gutter, and, the *circular* or endless-chain type which is continuous in its travel and cleans two gutters at a time.[4] These will be described in more detail later.

The general principle of both cleaners is best described as that of a traveling chain with attached slats which is located in the barn gutter and, in operation, carries manure to a pit or elevator from where it is disposed of. In some cases the manure goes directly to the spreader. The chain is driven through a gear-reduction system by a standard electric motor.

In operation, the bedding and manure are first shoved into the gutter, then the cleaner push-button is pressed, and in from 4 to 10 minutes the barn is cleaned.

[4]A third type, the oscillating type, now is also being used quite extensively.

WIND-UP CLEANER

The wind-up cleaner is designed to wind up the apron on a drum at the end of the loading chute as it cleans the barn. After the load has been pulled out, the apron is brought back to its original position with a second motor-driven drum at the opposite end of the gutter. With this type cleaner, it is convenient to make the loading elevator a continuation of the gutter (see cover and Fig. 1).

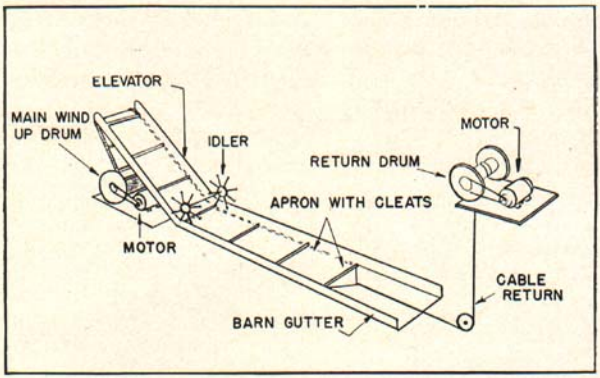

Fig. 1. Diagrammatic view of a "wind-up" type barn cleaner. Angle of elevator rise should not exceed 30°.

THE APRON

Since this is the working part of the cleaner and the part that will require the most maintenance, it is well to give careful consideration to sturdy construction. A good apron can be made by welding 1½-inch angle iron between two No. 62 binder chain at 18- to 24-inch intervals. If wooden slats are used, they should be standard 2″ x 2″ material and free from knots. A few variations are listed below. One dairyman used 5/16-inch log chain instead of flat binder chain. The objection to log chain is that it does not wind on the drum as easily as flat chain. Steel cable is satisfactory for a short time only, as manure acids attack the small wires, making replacement necessary at frequent intervals.

In one installation observed, the cross-slats were riveted, using ¼-inch rivets and ⅛-inch backing plate (Fig. 2). Bolts are not recommended since they are more likely to catch on obstructions.

Also shown in Fig. 2 is a spider-wheel which acts as a direction changer at the point where the apron starts up the elevator. In this installation it can be noted that the wheel is spring-loaded to allow it to rise over very heavy manure loads.

Fig. 2. Spider-wheel. Note the well braced construction and spring tensions. The wheel holds down the apron as it starts up the loading chute.

THE GUTTER

In most installations it will not be necessary to change the present gutter if it conforms approximately to a standard gutter, which has a 5-inch drop on the alley side, is 16 inches in width and has an 8-inch rise on the stanchion side. The gutter should not be less than 12 inches wide for good results. Wide, shallow gutters are desirable for greater contact and ease in winding the apron.

LOADING ELEVATOR

It should be remembered that in most installations at least a spreader load of manure will be removed each day. The power required to move this load is considerable, and it is necessary to

Fig. 3. Note strong foundations. The unit is anchored in cement. Mr. Cable of Bath, Michigan, is holding the clutch handle. The power unit and winding drum are located above the base.

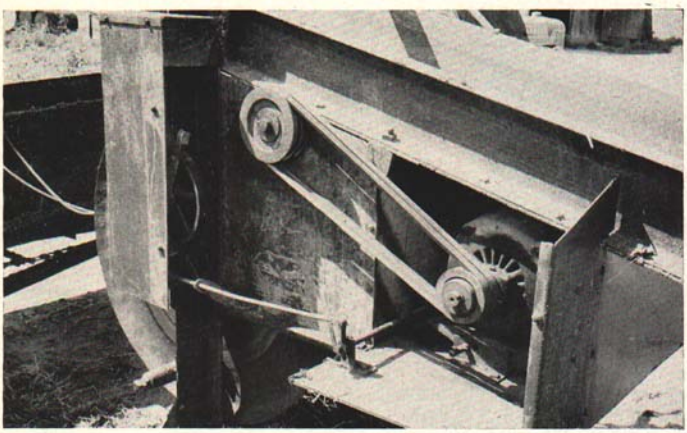

Fig. 4. Winding drum and shut-off. The brake can be seen where it rubs on the winding drum. Note the two gears which operate the automatic shut-off.

provide the motor and drum with a sturdy foundation. The power unit and winding drum will ordinarily be fastened under the end of the loading elevator.

To insure sufficient strength in the elevator, a farmer near Bath, Michigan, has used 2″ x 6″ channel iron as the sides of the elevator chute with steel boiler plate forming the bottom. He has also provided concrete foundations for all supporting members (Fig. 3). In most cases the elevator will be outdoors and should be provided with a cover to protect the unit as well as to prevent rain from running down the elevator into the barn.

WINDING DRUM

The winding drum shown in Fig. 4 is supported by 4″ x 4″ steel angle iron embedded in a concrete foundation. A 6-inch hub is used as the drum. Two ½-inch cables fasten the apron to the drum. In this installation, a two-horse-power motor is geared down to 9 r.p.m. which gives an initial speed of 14 feet per minute to the apron. This speed will increase as the apron winds on the drum which increases in diameter. A simple brake is provided to prevent back-lashing as the apron is unwound.

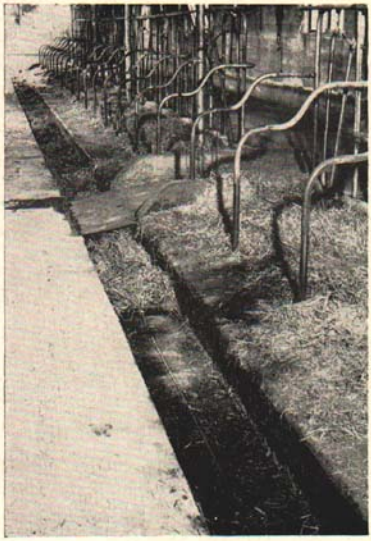

Fig. 5. The interior view of the A. J. Cable dairy barn, showing the single gutter and the return cable on the lower end. Note how clean the gutter is left as the apron moves out.

CLUTCHES

Wind-up-type cleaners may have a clutch on the winding drum to enable the motor to reach operating speed before starting the apron. The return mechanism should have a clutch to keep the motor from running backwards as the apron moves out.

AUTOMATIC SHUT-OFF

This is a desirable arrangement although not necessary for successful operation. Fig. 4 shows one type which is simple and effective. Parts of two gears are shown. The upper gear has a finger attached which is so placed that after the necessary number of revolutions of the drum, it trips the rod which is, in turn, fastened to the power switch.

RETURN MECHANISM

Figure 1 shows the gear and drum arrangement of a return mechanism. This unit has a clutch between the motor and drum. It also has a "dog" clutch on the drum shaft that acts as protection if the apron should catch.

Figure 5 shows the appearrance of the loaded apron and

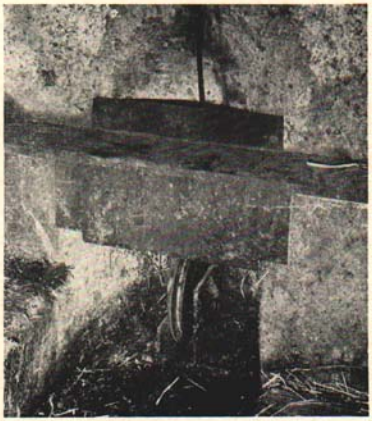

Fig. 6. Gutter pulley. This pulley is used in pulling the apron back into place.

also a cleaned portion of the barn gutter. Figure 6 shows the placement of the pulley for the return cable.

Fig. 7. Power, clutch and shaft arrangement of a dairy barn where one motor and a gear reduction unit operate both aprons of a two-gutter, face-in-type barn. The clutches are grab type. (George Bailey farm in Hillsdale County.)

POWER REQUIREMENTS

Several factors affect the power requirements:

1. Speed at which the apron moves.
2. Length of the gutter and number of cows served.
3. Frequency of cleaning.

Most cleaners will require from 1½ to 3 h.p. for the apron mechanism and ¼ to ½ h.p. for the return.

Fig. 8. The interior view of a dairy barn, showing the apron-return arrangement using one motor to operate two drums. Clutches are friction-disk type.

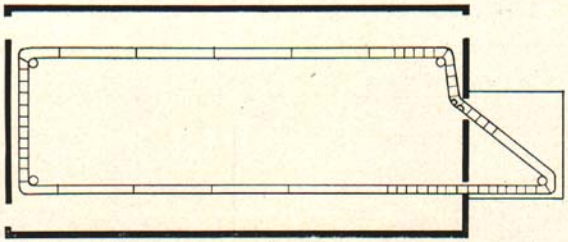

Fig. 9. (Above) Layout of endless-apron-type cleaner where land slopes away from end of the barn, permitting a manure spreader to drive under the extended gutter. This is all in one plane and no elevator is needed.

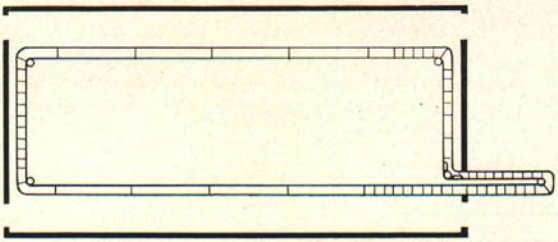

Fig. 10. (Above) Layout of endless-apron-type cleaner in two-gutter barn. Power unit is located on top of elevator (see Fig. 18). For details of reverse curve, see Fig. 19.

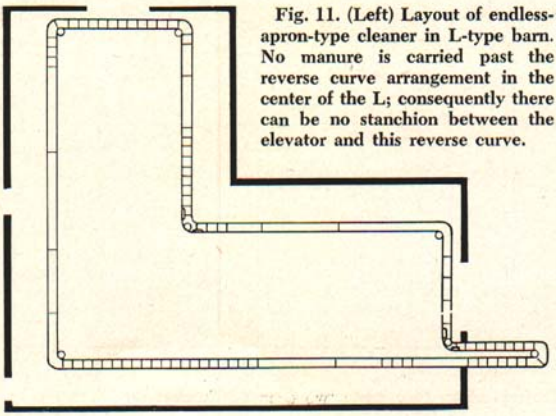

Fig. 11. (Left) Layout of endless-apron-type cleaner in L-type barn. No manure is carried past the reverse curve arrangement in the center of the L; consequently there can be no stanchion between the elevator and this reverse curve.

DOUBLE OPERATION FOR A TWO-GUTTER BARN

Figure 7 shows a power arrangement whereby one motor is used to operate the aprons of both gutters of a two-gutter barn. A clutch is installed at each drum. Also note that the spider wheel has been omitted since the angle of rise is only about 10°.

This installation uses a 3 h.p. motor drive and cleans each 88-foot gutter (22 cows) in 2 minutes.

Figure 8 shows the power arrangement of the return mechanism of the installation mentioned above. A ¾-h.p. motor is used, and the clutch arrangement makes it possible for one man to operate the return mechanism.

Angle iron slats were abandoned on this installation in favor of ⅛″ x 1″ strap iron so a smoother roll could be obtained on the drum.

ENDLESS-APRON-TYPE CLEANER

The fundamental difference between this type of cleaner and the previously described wind-up type is that only one chain is used, which permits the apron to turn corners as it moves around the circuit. It travels round and round, picking up the manure from the gutters and dropping it off into an elevator or into a spreader. No return mechanism is needed. Figures 9, 10 and 11 show layouts of cleaners of this type. Figure 12 shows the corner where the apron drops the manure onto an auxiliary elevator.

Fig. 12. Business corner. Three operations take place here. The manure is dumped onto the loading chute. The apron is driven at this point by the sprocket. The slats are cleaned as they move along.

The use of an auxiliary elevator or the pit presents a sanitation problem that should not be minimized. If this type of installation must be used, provision for washing and draining must be installed for satisfactory results.

A cheaper installation, and one that greatly improves the sanitation, is possible on a "sidehill barn." Then the conveyor can be extended so that a manure spreader can be driven directly under the elongated gutter (Fig. 9). A shed must extend over this trench so it can be used at all seasons of the year.

The endless apron-type cleaner is most practical on double-gutter barns of either the face-out or face-in type (Fig. 10).

A layout showing an installation in an "L" shaped barn is shown in Fig. 11. Manure will not travel through the reverse curve sprocket assembly so the point of discharge is limited.

THE APRON

The slats of the continuous apron are fastened at only one end, enabling the apron to turn corners. The chain may be of the binder bull-chain-type or one of the special commercial types available. Successful units are in operation using both angle-iron and treated-wood slats. The angle-iron slat has longer life and perhaps does a better cleaning job, while the wooden slat is less expensive and may have the advantage of being easier to clean and replace. Apron speeds

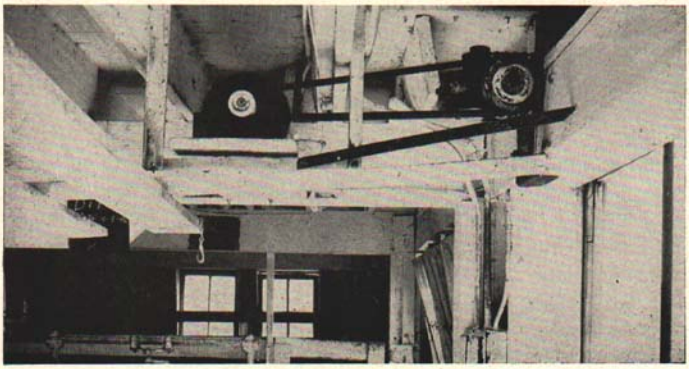

Fig. 13. Overhead power unit. The gear reduction box is fastened to barn timber and runs the shaft outside the door by means of a chain. (See also Fig. 14.)

vary from 10 to 30 feet per minute.

In selecting the chain, one must consider the load that will be required to be moved. If the barn is cleaned twice daily, figure approximately 40 pounds per cow. The working strength of the chain should not be more than one-fourth of the maximum strength so long chain life will be assured.

Slats should be 1½″ x 1½″ angle-iron or 2″ x 2″ straight-grain hardwood with no knots. The slats in both cases are attached to the under side of the chain.

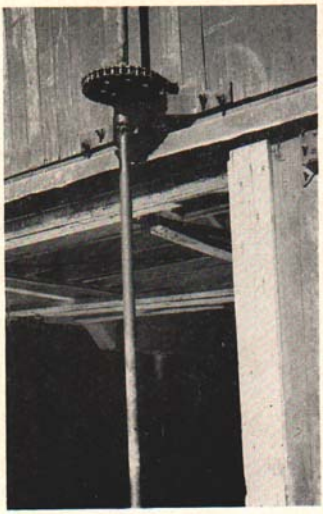

Fig. 14. Drive shaft. The gear box inside the barn drives the chain which turns the vertical drive shaft (see Fig. 13).

DRIVE MECHANISM

This type cleaner usually has the power unit near the ceiling, with a heavy shaft to drive the sprocket (Figs. 13 and 14). The main shaft has two bearings, one at

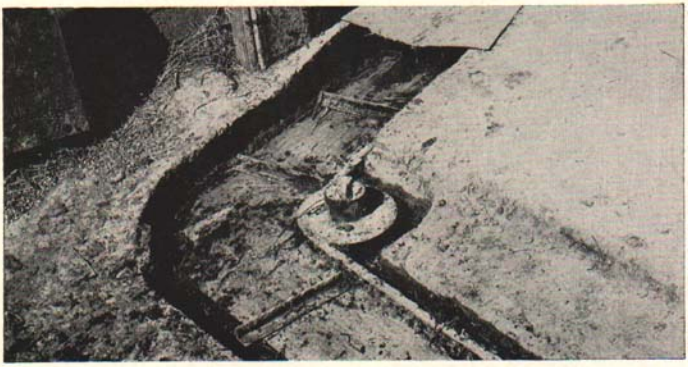

Fig. 15. Tightener idler. This idler is on an eccentric hub which is used in tightening the apron chain.

Fig. 16. The loading elevator on the Brook Brothers farm, Haslett, Michigan. This type is used on the double-gutter dairy barn in which an endless apron cleans the gutter and drops the manure onto the lower end of the loading elevator.

the motor and one mounted in the concrete at the gutter level. The drive sprocket is placed at the corner where the manure is discharged on the elevator.

TIGHTENER

Normal wear of the chain makes it necessary to provide some means of taking up the slack. Tighteners may be of several types. One is a corner sprocket mounted on an eccentric, while the other is an idler sprocket which is adjustable. Figure 15 shows the eccentric mounted type.

CLEANING ARM

Some means of scraping and cleaning the slats is usually provided. The cleaning arm is grooved to conform to the shape of the slat and so placed that it moves over each slat as it passes.

LOADING ELEVATOR

When first brought out, endless cleaners usually provided a separate elevator to load the manure—although is some instances it was possible to extend the gutter beyond the edge of the barn to drop the manure directly into the spreader. Where such an elevator is used, a shallow pit has usually been necessary.

The elevator shown in Fig. 16 is of the common endless conveyor

Fig. 17. Part of metal cover removed to show details of slats turning on themselves.

type, with the apron returning under the loading ramp. With this unit liquid manure may collect under the ramp.

To eliminate that objection, the second type has been developed, using the same type of chain as used in the gutter but with the empty return alongside and on the same level as the loaded section, instead of beneath it. All liquid can be removed with this type. The elevator usually runs faster than the apron.

ENDLESS APRON CLEANER AND LOADING ELEVATOR COMBINED

An effective type of barn cleaner now on the market is a combination cleaner and elevator. This system has the same general type of chain and drive as do other circular-type cleaners, but the chain apron passes through the side of the barn and continues up the elevator and back.

This arrangement eliminates the necessity for a pit and extra

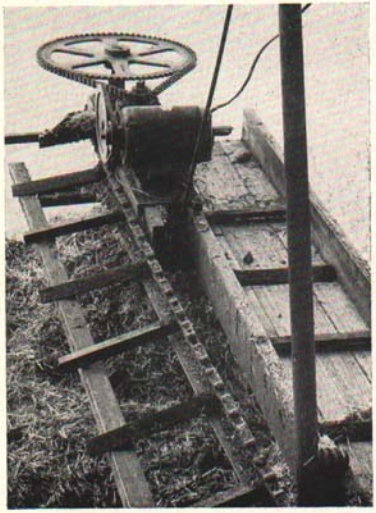

Fig. 18. Drive unit for combination elevator and cleaner located on the Platt farm near Mason, Michigan.

Fig. 19. Detail of slats turning on themselves (Platt farm).

elevator, thus greatly increasing the sanitary features of the cleaner. It also simplifies the drive and eliminates the need for the second motor and drive mechanism for the elevator.

(Figs. 9, 10, and 11 show layouts in which this type of cleaner is used in various shaped barns.)

Figure 17 also shows details of construction in which slats turn on themselves. A guide forces the slats to ride up over the end of the slat that has just turned the corner.

Figure 18 shows the location of the single-drive unit. The power unit is adjusted to maintain proper tension on the chain. This chain is a continuation of that shown in Fig. 17.

Note, the location of the cleaning arm in contact with the slat as shown in the upper left corner of the picture.

The rate of travel of the cleaner is 20 to 21 feet per minute and the angle of incline of the elevator is about 30°.

At the center left of Fig. 19 can be seen the angle-iron guide that holds the conveyor slats up in order that they may make the turn without interfering with those that have already made the turn.

POWER

Power requirements for endless chain type cleaners is about the

Fig. 20. Corner idler. Note chain construction and steel rail in bottom of gutter which takes all wear.

same as for the wind-up cleaner. Motors will usually be from 1½ to 3 h.p.

Figures 20-25 show important details of the construction and operation of endless-chain type barn cleaners.

With the corner idler maintaining even tension along the chain, a steel rail set in the gutter bottom can take the wear instead of the concrete curbing (Fig. 20).

For the over-passes, concrete slabs or removable metal plates are recommended (Figs. 21, 22 and 23). Planking may not provide the livestock sufficient protection.

Figure 24 shows a cleaner in actual use, and Figure 25 a double-gutter installation.

Fig. 21. Over-pass at the end. Note grooves on the top of the gutter for cover plates. Elevator and drive shaft in background.

Fig. 22. (Above) Metal over-pass for cleaner across drive. Elevator in background. Farrell farm near Williamston.

Fig. 23. (Above) Corner over-pass. Before the operator starts the cleaner, all manure is scraped into the gutter.

Fig. 24. (Right) Cleaner in operation.

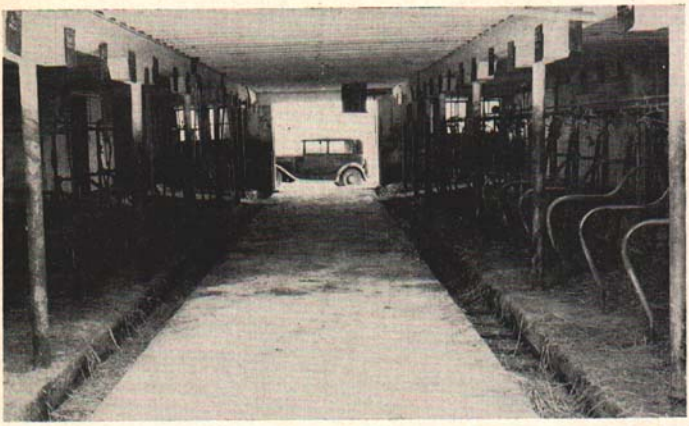

Fig. 25. The double-gutter dairy barn on the Brook Brothers farm of Haslett. The slats can be seen in the right-hand gutter. Straw is always placed in the gutter after cleaning.

COSTS OF BARN GUTTER CLEANERS[5]

Costs that should be considered in the installation and operation of a barn cleaner may be listed as follows:

1. Construction, including installation.
2. Depreciation and maintenance.
3. Operation.
4. Taxes, interest and insurance.

CONSTRUCTION

In considering a barn cleaner, the first cost is important to the average farmer. It may be less expensive to purchase a commercial unit if the barn is adaptable, although many farmers have built their own. The simple wind-up type will cost $300 and up, installed, while the double-gutter unit may cost around $1,000. These prices are based on current small production and should be more favorable as the volume of business increases.

[5]Costs, as given here, were actually determined in a 1947 survey on construction and operation. However, the results of a re-check concluded in 1950 compare so favorably no revision has been necessary.

OPERATION COST

In order to determine actual power costs, in 1947 meters were placed on both single-row wind-up and endless-chain-type units.

The wind-up cleaner used from 2½ to 4 KWH per month, while the double row cleaner used from 4 to 6 KWH. On a yearly basis, this would amount only to from 3¢ to 7¢ per cow, depending on the type cleaner and number of cows served. From these figures it can be seen that power costs are extremely small.

DEPRECIATION

Depreciation figures are difficult to obtain because few commercial cleaners have been in operation for more than 5 years. Probably the chain should be replaced in 5 years, although with proper care it might last much longer. The remainder of the machine could reasonably be expected to last at least 20 years.

COST OF TWO TYPES OF CLEANERS

Detailed cost studies were made of two home-made machines which represent the two types of barn cleaners, as follows:

Specification of Barn Cleaners

Item	Wind-up Type	Endless Apron Type
Length of cleaner	90′	164′
Width of cleaner	17″	16″
Distance between slats	15″	18″
Depth of gutter (high side)	10″	10″
Slat material	steel	steel
Motor H.P.	3	2
Time for cleaning each day	7 min.	8 min.

Cost Data

Item	Wind-up Type	Endless Apron Type
Original cost installed	$800.00	$1,100.00
Depreciation and maintenance (8%)	64.00	88.00
Interest on investment (6%)	48.00	66.00
Operator's time @ $1.00/hr.	16.00	26.00
Electricity cost/yr. (energy)	.66	1.36
Total yearly cost	128.66	181.36
Cost per cow	5.84	5.34
Cost to do work by hand (figured @ $1.00/hr.)	362.66	545.00
Dollars saved by machine per year	234.00	374.00
Number of cows served	22	34

These figures will vary considerably in different installations but may be of value in estimating probable cost. It is reasonable to expect that cost per cow would drop rapidly as the number of cows increased.

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