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Electric Hay Hoists

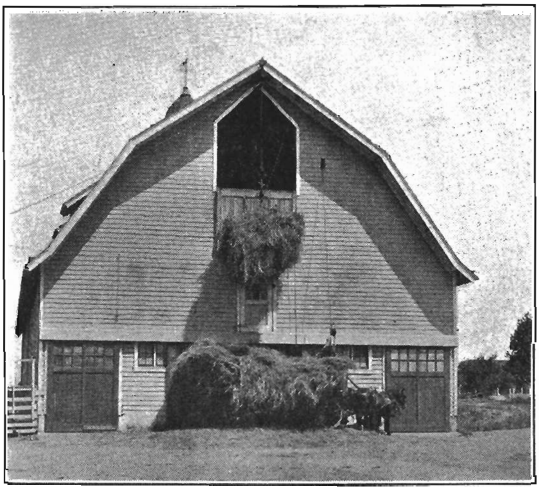

Fig. 1.

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SUMMARY

A good power hoist will replace the pull-up team and driver.

A hoist will operate satisfactorily with either fork or slings.

A hoist can be operated conveniently and satisfactorily by the man on the wagon.

A hoist will make the use of a gravity pull-back for the fork convenient and practical as the brake will stop or slow up the carriage or fork at any place.

A hoist saves a little time in starting, stopping, and in setting a fork.

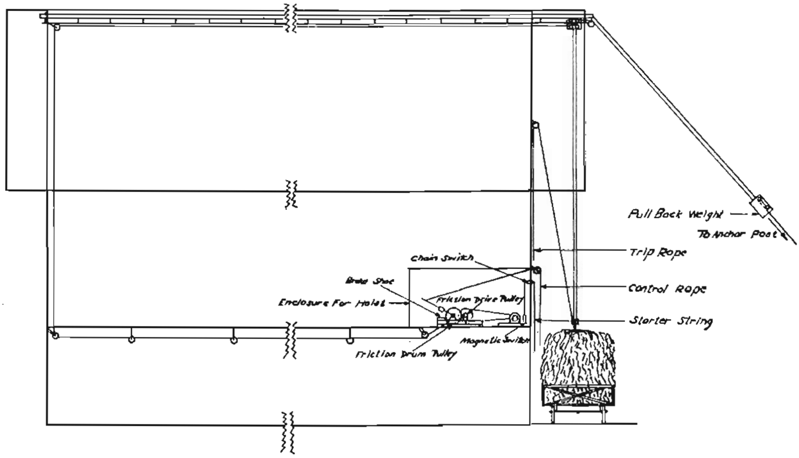
A hoist makes possible the use of a larger fork than can be easily set by hand since the fork can be put in position on the load largely by the aid of the hoist.

The hoist will not elevate the hay faster or in larger loads than is possible with horses without danger of breakage to the carriage or tracks.

A good power hoist can be purchased for $80.00 to $100.00.

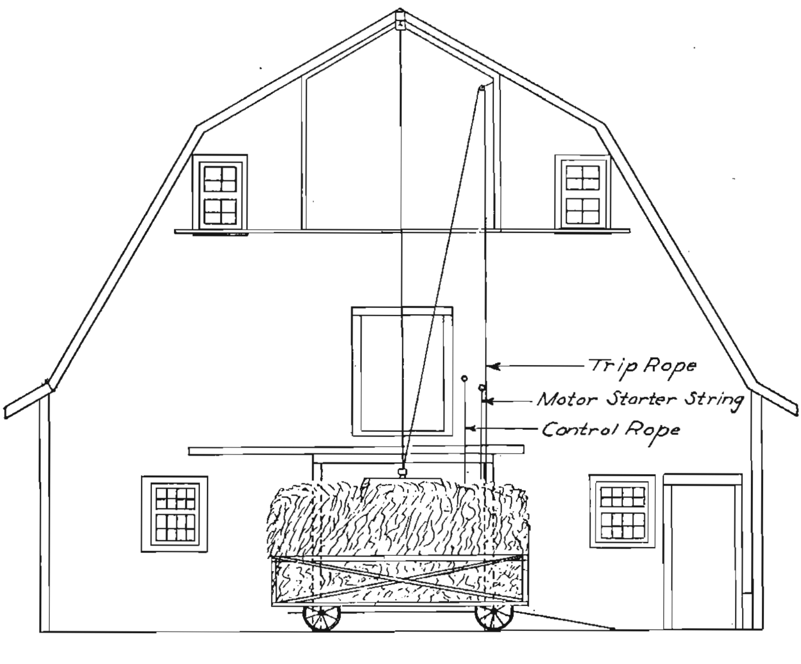
A power hoist uses one-third k.w.h. per ton of hay hoisted and the power costs one cent per ton at three cents per k.w.h.

One h.p. is required for each 135 to 150 pounds of load at a hoisting speed of 125 feet per minute.



SIDE VIEW—SHOWING ARRANGEMENT OF EQUIPMENT

Fig. 2.



FRONT VIEW—SHOWING CONTROL ROPES

Fig. 3.

Electric Hay Hoists[1]

By F. E. Price, A. W. Oliver, and E. L. Potter

The experimental work reported in this bulletin was conducted cooperatively by the Agricultural Engineering department and the department of Animal Husbandry. The following members of these departments contributed to this project: F. E. Price, C. J. Hurd and Geo. W. Kable, of the Agricultural Engineering department; E. L. Potter, A. W. Oliver and B. W. Rodenwold of the Animal Husbandry department.

This is one of a series of publications by the Agricultural Experiment Station giving facts regarding time- and labor-saving uses for power in farming. Every farmer must decide for himself whether a power hay hoist has a place in his operations and these facts are presented for the purpose of aiding in making such a decision. The specifications are given herein with the intention of aiding manufacturers in building hay hoists that will meet the requirement of the farmer.

Experience has proved that the man in industry or agriculture who supplements his own efforts by judicious use of power increases his earning capacity.

WHAT A POWER HAY HOIST WILL DO

A power hoist will hoist hay satisfactorily with a fork or sling. Also, it will make the use of a gravity pull-back for the fork more workable since the brake on the hoist will stop or slow the carriage or fork at any place. By using a power hoist the use of an extra large fork of either the Jackson or grapple type is more convenient as the fork can be lowered to the place at which it is to be set, thus eliminating the necessity of lifting or carrying the fork.

The power hoist will replace the "pull up" or derrick team and driver. If a boy with a saddle horse is used to pull back the fork, the hoist will also replace them.

WHAT A POWER HAY HOIST WILL NOT DO

The power hoist will not hoist hay much faster than horses will since the hay carriages, track, and trip dogs are designed for a speed about equal to the speed of a walking horse, which is from two to two and one-half miles per hour, or about 200 feet per minute. If the hoisting is done at a faster speed the equipment is soon broken or put out of order, thus causing loss of considerable time in repairing equipment.

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[1]The preparation of this bulletin and the experimental work on which it is based have been in cooperation with the Oregon Committee on Electricity in Agriculture. This committee is made up of farmers, business men, and representatives of the State College, Grange, Farmers' Union, public utilities and equipment companies. Its purpose is "to determine and disseminate facts regarding the use of electricity for profit and convenience on Oregon farms."—James T. Jardine, Director, Agricultural Experiment Station; Chairman, Oregon Committee on Electricity in Agriculture.

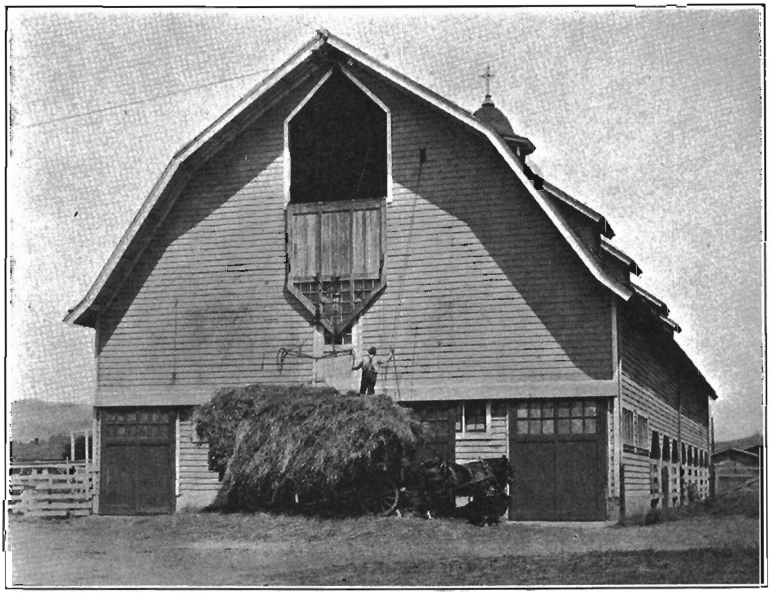

Fig. 4. A power hoist permits the operator to lower the fork into position to set for the next hoist.

TABLE I. HORSES VS. POWER HOIST FOR HOISTING HAY

	No. of fork lifts per load	Weight per lift	Unloading time per ton	Fork setting time	Hoisting time	Getting ready to pull back	Pull-back time
		lbs.	*minutes*	*seconds*	*seconds*	*seconds*	*seconds*
Power* hoist	5	496	15.74	95	59	16	57
Horses on hoist....	5	482	19.71	126	41	22	73

*The power hoist used in this test was of old design, and the time for the operation is much slower than for recent hoists.

The foregoing tests were in a large barn measuring 45 feet from the ground to the track. The hay was moved back in the barn from 30 to 100 feet. With a barn of this size when a team was used to elevate the hay it was necessary to use a boy with a third horse to pull back the fork. When hoisting with horses a gravity pull-back on this barn was unsatisfactory as the carriage would develop too much speed in returning, thus causing much breakage and other damage to equipment. The power hoist with the gravity pull-back (or separate pull-back drum) proved itself capable of all the work of hoisting the load and bringing back the fork in an entirely satisfactory manner. The differences in time and convenience were slight, but they were in favor of the hoist. The men were at first somewhat afraid of the hoist, but soon found that when using the electric hoist the load was under better control than when hoisting with a team. This was particularly true whenever there was any tendency for the cable

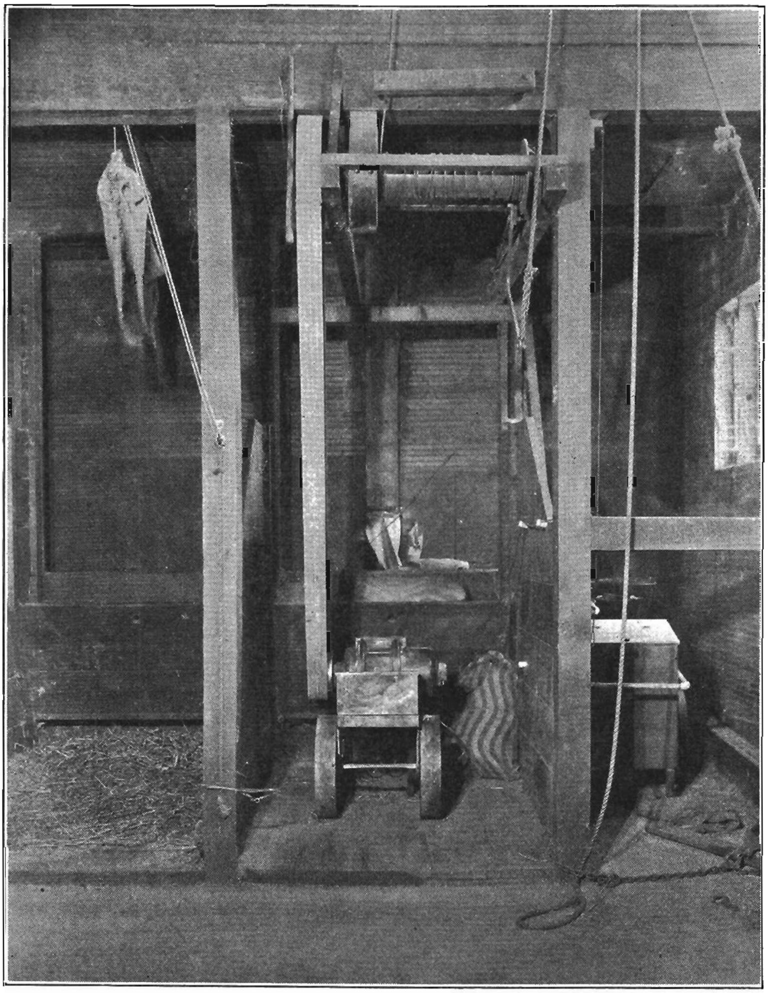

Fig. 5. The internal gear hoist showing single lever control attached to a rope which runs through a pulley near the top of the barn and returns to the operator on the wagon which is located in the driveway in front of the hoist.

The hoist is located under the second floor of the barn with the portable motor on the ground floor.

to twist upon entering the carriage. In such case the load could be stopped and held at any point, or if repairs were necessary could be lowered gradually to the wagon.

The power hoist is useful to hoist grain in sacks to the top of bins. Also the hoist is often very handy for doing miscellaneous hoisting about the farm.

REQUIREMENTS OF A GOOD ELECTRIC HAY HOIST

Speed. The speed of hoisting must be approximately the same as horse-drawn equipment; that is, the cable or rope should move at 225 to 275 feet per minute. Greater speed causes severe strain on the track and carriage and usually results in frequent breakdowns. The belt pulley on the hoist should be of sufficient diameter to permit the use of a motor pulley 4½ inches in diameter or larger.

Load. The maximum working pull on the rope or cable will be about 500 pounds, thus providing for lifting a 1000-pound load since a double line is used in lifting from the load to the track. An emergency load of 2000 pounds should be provided for. This should also be a basis of the brake design.

Positive brake. Hay hoist loads vary from 200 to 1000 pounds, and the brake must be capable of holding the maximum load and have a quick action. When the control rope is released the brake must be automatic. A tangled trip rope, twisted cable, catching of fork on the wagon, the man on the wagon getting in a fouled position, or the carriage dogs sticking are a few of the troubles that would require a quick stop of the hoisting drum.

The drum. (1) The diameter of the drum must be not less than 6 inches and preferably 8 inches or more.

(2) The drum should start easily and turn freely when the control lever is placed in neutral position.

(3) The size of the drum should be sufficient to hold 200 feet of 1-inch manila rope or ⅜-inch cable with capacity for at least 50 feet of line in the first layer on the drum.

Control. (1) The motor is started with no load and kept running during the time each load of hay is being hoisted into the barn. The motor starting switch should be located so that it can be operated from the wagon. (See motor overload protection and starting device.)

(2) A clutch, friction drive, or similar device that will start the drum slowly under full load and which can be engaged by pulling the control rope is required.

(3) The single control rope operating the brake and clutch should have three distinct positions, as follows:

a. Stop—clutch free and brake engaged (no pull on control rope).

b. Neutral—clutch free and brake free (pull-back position slight pull on control rope).

c. Hoisting—clutch engaged, brake free (maximum pull on control rope).

(4) The control lever and control rope extending to the operator on the wagon should move sufficiently in passing any one operating position (stop, neutral or hoisting) to the other so as not to be confusing to the operator who cannot see the hoist to observe what position is being taken.

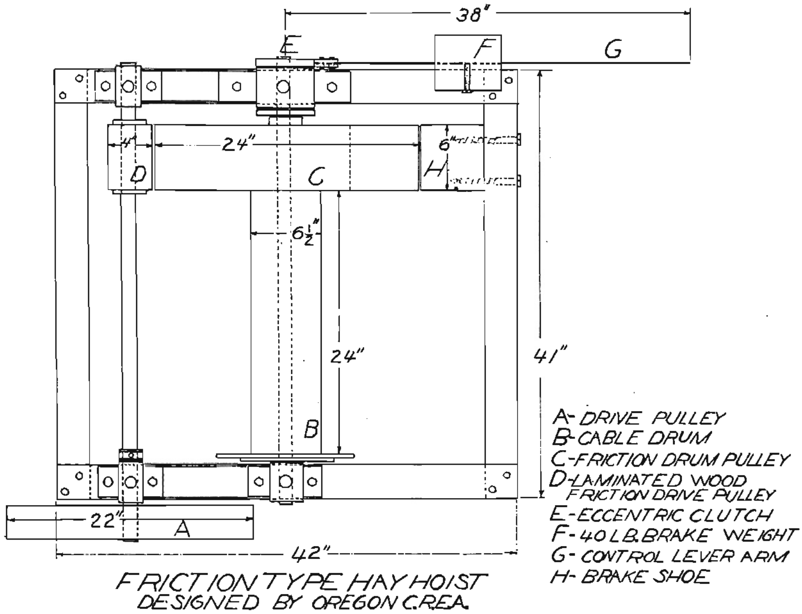

Fig. 6.

(5) The control system described requires that the brake be engaged by a spring or by a weight. The brake is thus on at all times except when released by a pull of the control rope.

Pull-back. A gravity pull-back is preferred and requires only the pulleys, weight and cable shown in Fig. 2. If a mechanical pull-back is used the speed should be the same as for hoisting.

Fig. 6 gives a top view of the friction-type hoist designed by the Oregon Committee, Electricity in Agriculture. It embodies all of the specifications as outlined above and has proved very satisfactory.

TYPES OF HOISTS STUDIED

After using one standard make of hay hoist for several years and one special-built hoist for one year, sufficient experience was gained to prepare specifications for an improved hay hoist. Two new hoists were constructed by Hesse-Ersted Company of Portland, Oregon, and supplied for experimental use.

One of these hoists is an internal-gear hoist of the planetary type with a 14-inch pulley on the hoist for belt drive from a 1750-r.p.m. motor. The other is a friction-driven hoist with a 22-inch belt pulley on the counter shaft and a 4-inch laminated spruce friction pulley which drives the 24-inch cast-iron friction pulley, which is integral with the drum. Each hoist was operated by a single lever control which was extended to the man on the wagon by a rope. A spring was used to engage the brakes automatically on the internal-gear hoist while a weight on the control lever engaged the brake on the friction hoist. The brakes hold a full hoisting load at any time the operator releases the control rope, thus giving assurance of a quick automatic stop if any emergency should develop.

The internal-gear hoist is very compact with a free running drum and has no exposed gears. The control arrangement is entirely satisfactory. The only criticism of this hoist is that it has cast gears which are quite noisy, causing the men operating the hoist to have some fear of it. Slowness of the men at times in operations was attributed to the noisy gears. The manufacturer reports that he will use cut gears for additional hoists of this type, thus practically eliminating this one criticism.

The friction-drive hoist proved entirely satisfactory. No difficulty was experienced in stopping a full load at any point between the wagon and the track and starting it again as easily as with a team. The fact that it was very quiet in operation appealed to the men who used this hoist.

The only improvement that has been recommended after using this friction hoist to put more than 100 tons of hay and straw in one of the college barns is that a guard be provided for the friction pulleys so that the cable or rope cannot become caught between these pulleys if the operator should forget to release the control rope when the fork is returned to the wagon, thus permitting the drum to unwind more rope or cable owing to the inertia of the drum. The operator soon learns to release the control rope, thus engaging the brake and stopping the empty fork a few feet before it reaches the load in order to push the fork to the position for the next lift and then lower it slowly into place (see Fig. 4). By this method it is not necessary to lift the fork by hand.

COST OF HAY HOISTS

The price range for the internal-gear hoist and friction-drive hoist is from $80 to $100 f.o.b. Portland, Oregon. The friction hoist is less expensive to construct and should sell for about $20 less than the internal-gear hoist, which requires more machine work in construction and is fitted with roller bearings.

POWER COST

The power cost when using an electric motor for hoisting hay into a barn amounts to approximately 1c per ton when the electric power rate is 3c per k.w.h., the power consumption being ⅓ k.w.h. per ton. In the 1928 tests 53.9 tons of hay was hoisted into the horse barn at the College using 18 k.w.h., which would amount to 54c at 3c per k.w.h. An electric motor was also used at the beef cattle barn, 71 tons of hay being hoisted into the barn using 22 k.w.h., which at 3c per k.w.h. would amount to 66c.

It is assumed that other uses would be made of the electric motor when not needed on the hay hoist; otherwise the power rate would probably be more than 3c per k.w.h.

POWER REQUIREMENTS AND SIZE OF MOTOR

A recording wattmeter was used to make load curves of several lifts. Each curve had practically the same characteristics.

The charts show that the greatest load is in pulling loose each fork load from the wagon, followed by a decrease in power until the load is about half way to the track, when the power demand begins to increase. As the carriage reaches the track, the power demand is nearly as great as tearing away from the wagon. When the cable is badly twisted, the power demand as the load reaches the track is sometimes twice that between the wagon and this point. The power required to move the load along the track is one-fourth to one-half that required to hoist, even though the speed is twice the hoisting speed.

TABLE II. SUMMARY OF OPERATIONS FOR FRICTION HOIST, 1928

Operating Data

1. Speed of cable—225 feet per minute.
2. Distance from load to track—40 feet.
3. Amount of hay hoisted—71.27 tons.
4. Power used per ton—0.31 k.w.h.
5. Kind of hay—oats and native grass.
6. Average weight per load—1680 pounds.
7. Average weight per lift—240 pounds.
8. Average unloading time per ton—22.9 minutes.

Time Study—Average Values

Distance back in mow	To set fork	To hoist	To pull back
feet	*seconds*	*seconds*	*seconds*
15	65.0	24.2	46.5
35	63.0	32.5	47.4
45	68.4	33.5	51.4
55	58.3	36.2	60.0
65	57.4	39.2	52.6
43 average	62.5 average	33.0 average	51.6 average

TABLE III. SUMMARY OF OPERATIONS FOR INTERNAL-GEAR HOIST, 1928

Operating Data

1. Speed of cable—270 feet per minute.
2. Distance from load to track—38.5 feet.
3. Amount of hay hoisted—53.9 tons.
4. Power used per ton—0.33 k.w.h.
5. Kind of hay—oat and native grass.
6. Average weight per load—2365 pounds.
7. Average weight per lift—338 pounds.
8. Average unloading time per ton—15.4 minutes.

Time Study—Average Values

Distance back in mow	To set fork	To hoist	To pull back
feet	*seconds*	*seconds*	*seconds*
15	69.0	34.3	23.1
25	52.0	28.5	38.0
35	59.0	26.0	39.0
45	61.0	29.2	37.2
55	53.0	29.5	47.0
65	63.0	30.0	48.5
75	63.5	32.3	54.0
45 average	60.0 average	30.0 average	41.0 average

Table III gives the summary of operations for the internal-gear hoist, showing that the average lift was 338 pounds in hoisting 54 tons. There was no check made of the exact weight of each lift. Taking an average weight of a series of lifts, it was found that it required approximately 2.25 h.p. (2.0 k.w. input) to hoist 300 to 350 pounds to the track. This is at the rate of $\frac{2}{3}$ to $\frac{3}{4}$ h.p. per 100 pounds.

A power curve was taken while unloading a 1900-pound load of straw with two slings, or an average of 950 pounds per lift, and it showed a demand of 6.5 h.p. (input of 5.8 k.w.) to tear away from the wagon and 4.0 h.p. (4.5 k.w. input) to lift to the track. This is at the rate of $\frac{2}{3}$ h.p. per 100 pounds for the maximum demand. This was done with a 5-horse-power motor.

It is entirely practical to expect satisfactory service from standard-make electric motors with a 200-percent load for short periods such as in operating a hay hoist where the time of hoisting averages approximately one-half minute, provided the line voltage is equal to that required by the motor. A 3-horse-power motor will therefore hoist a maximum of 800 pounds load and a 5-horse-power motor will hoist in excess of 1200 pounds at a cable speed of 250 feet per minute, which would give a hoisting speed of 125 feet per minute.

MOTOR OVERLOAD PROTECTION AND STARTING DEVICE

In order to start the motor from the load of hay, it will be necessary to use a magnetic starting switch with a chain switch or the usual push-button switch for remote control. This is the best type of starting switch for a 3-horse-power or 5-horse-power motor for general farm use, and will also include either fuse or thermal switch overload protection. In selecting the overload protection, specifications should provide for 200 percent load for one minute if a motor of less than 5 h.p. is used and loads of 800 pounds are to be hoisted.

It is possible to use a manually operated switch and overload protection at a lower cost, but it would be necessary to be within reach of the switch to start the motor, which would usually make it impossible to start the motor from the wagon.

SUGGESTED ARRANGEMENT OF THE HOIST IN THE BARN

Fig. 2 shows an arrangement for a power hoist in a typical two-story barn. The hoist and motor are set in the center and loading end of the barn, with a built-in cover to protect them from the hay. A door or sliding window can be built so that the operator on the load can see the hoist in operation. This opening also allows easy access to lower the motor and hoist to the ground, if so desired, at the end of the haying season.

Fig. 3 gives the front view of this arrangement. The window shown in this figure is larger than is necessary, but is perfectly satisfactory if this much space can be spared. This arrangement puts the hoist in such a position that all the cables and ropes are freed from the ground floor. With the pull-back cable and weight out in front of the barn, as shown in Fig. 2, the man on the load can see all of the important parts of his equipment and can have them under his complete control.

Fig. 5 shows a hay hoist located on the ceiling of the first floor of a barn at one side of the drive-way. This is a very good arrangement for this type of barn as no space is wasted and the motor is kept on the first floor.

COMPARISON OF HAY FORKS

Forks tested were:

- Grapple
- 6-tine Jackson (6 ft.)
- 4-tine Jackson (4 ft.)
- Double harpoon
- 2 double harpoons chained together

Fork	Fork lifts per load	Weight per lift	Unloading time per ton	Average hay dropped per load	Fork setting time	Hoisting time	Getting ready to pull back	Pull back time
		lbs.	*minutes*	*lbs.*	*seconds*	*seconds*	*seconds*	*seconds*
4 ft. Jackson	8.0	282	18.11	145	80.0	28.0	14.0	32.0
6 ft Jackson	9.0	219	30.50	94	103.0	51.0	6.0	43.0
Grapple	7.0	318	17.00	121	64.0	28.0	11.0	42.0
Double harpoon	9.0	228	21.00	175	51.0	29.0	12.0	51.0
Two double harpoon	4.5	513	17.00	174	97.2	59.3	16.9	59.1

The foregoing tests were conducted in a barn measuring 45 feet from the ground to the track and the hay was moved back in the barn from 30 to 100 feet. The hay in these particular tests was oats and vetch and alfalfa of medium length and in good condition for mowing away. The grapple fork proved most satisfactory in these power hoist tests. See figures 8 and 9 (courtesy Louden Mfg. Co.). It handled a large load and at the same time was easy to set. The operator would lower the fork until it was within about one foot of the load, then he would stop it with the brake, swing the fork over the exact place in the load that he wished, and lower it into position (see Fig. 4). The fork, however, was never lifted by hand. This fork weighed approximately 50 pounds and had some additional weight added to pull back the cable. It will therefore be seen that it was somewhat too heavy to handle entirely by hand.

The six-foot Jackson fork proved too hard to set even with the hoist and did not carry any more hay than the four-foot Jackson. The double harpoon fork gave good satisfaction when the hay was long and in good condition and properly loaded. The two double harpoons were also excellent but required some skill in loading the hay and in setting the forks.

If the hay is good and carefully loaded on to the wagon and the help good, the grapple fork has fewer advantages, but if the hay is short, too dry, carelessly loaded, or the help is unskillful, the grapple fork is distinctly superior to the other types tested. Under these adverse conditions the grapple fork will handle larger loads with less waste than the other forks tested. The grapple fork is also somewhat more convenient in picking up the hay that drops from the wagon.

These foregoing statements apply only when the fork is used with a power hoist.

The use of slings compared to grapple fork is a matter of personal choice as there is little or no difference in actual time required to unload the hay. There is always the chance, however, of the slings tripping as they leave the wagon and dropping the loose hay on to the wagon. If a sling is tripped and the hay dropped on to the wagon, it is necessary either to pitch the hay on to the sling again or to have a fork at hand to be attached to pick up the hay.

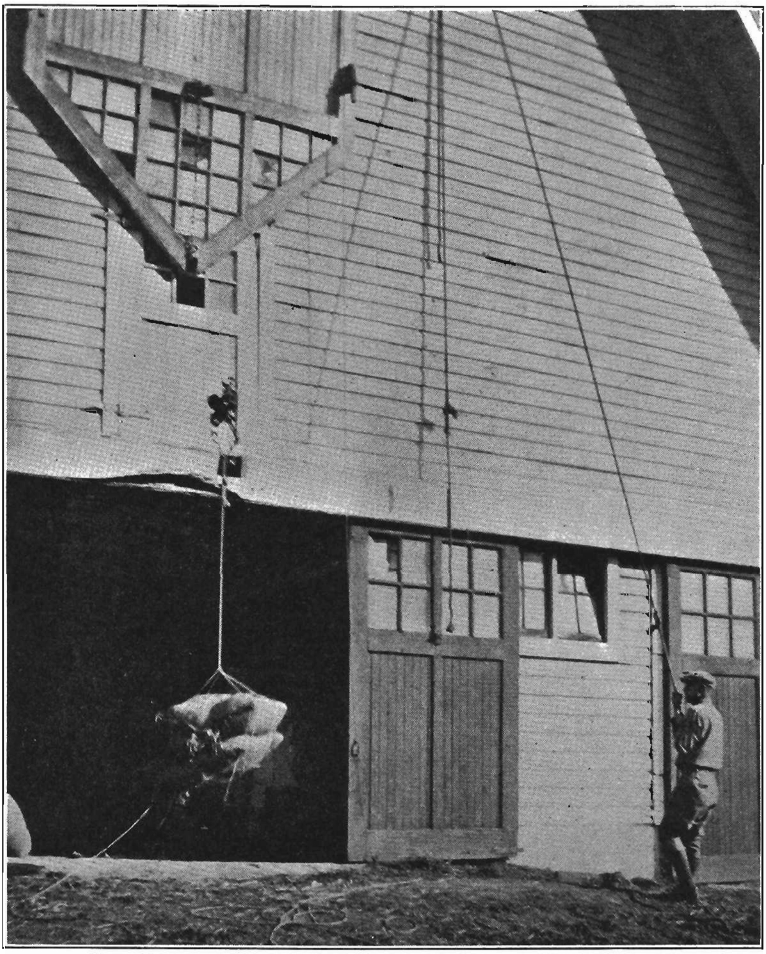

Fig. 7. Hoisting sacks of grain to be emptied into bins. Operator is pulling the control rope to engage the hoist clutch. A hay sling trip is used to drop the sacks.

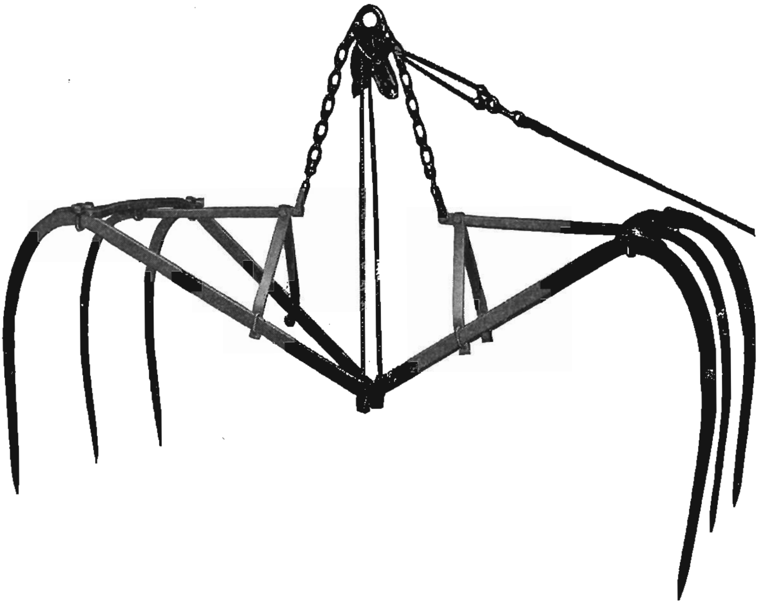

Fig. 8. Grapple fork open.

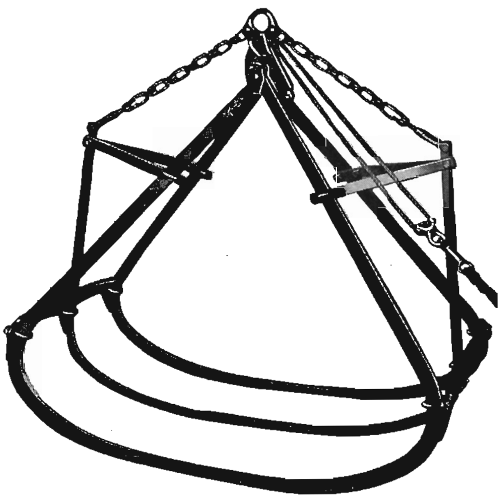

Fig. 9. Grapple fork closed.

TABLE IV. SLINGS VS. FORKS

	Ave. wt. of loads	No. of lifts per load	Ave. wt. of lift	Unloading time per ton	Unloading time per load	Setting	Hoisting	Pull-back
	lbs.		*lbs.*	*minutes*	*minutes*	*seconds*	*seconds*	*seconds*
Grapple fork	1650	4.6	365	13.34	10.4	37.6	34	27
Slings	1472	2.0	686	14.32	9.0	52.0	37	52
	Average setting of slings on wagon				1.54			
					10.54			

CABLE VS. ROPE

Steel plow cable has certain advantages over rope for hoisting hay. These are as follows:

Steel cable will wear 10 to 12 years while rope will wear only about 3 years.

Steel cable is more adapted to power hoists than rope, owing to the smaller diameter of the cable.

The cost of steel cable is less per year than rope (see Table V).

TABLE V. COST OF STEEL CABLE COMPARED TO ROPE

Kind and size of line	Cost per foot	Life in years	Cost per foot per year
3/8-inch cable	10.0c	10	1.0c
3/4-inch rope	4.4	3	1.47
7/8-inch rope	6.66	3	2.22
1-inch rope	7.89	3	2.63

Cable is more reliable since rope breaks more than cable, especially when the rope is in the third year of its use.