Factors to be considered in LOCATING, PLANNING, and OPERATING COUNTRY ELEVATORS

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SUMMARY

This study of the facilities, equipment, and methods of operation of a representative number of country elevators in Indiana was undertaken to provide information needed by people who desire to build new elevators as well as by operators who desire to make improvements in existing facilities. The older country elevators studied were originally constructed for the movement and storage of grain. Through the years, the need for maximum utilization of labor and facilities led to the practice of performing custom services for farmers and selling side-line merchandise. The volume of side-line merchandising has grown to the point that, for the period 1947-49, the income from it was 66 percent of the total income of the elevators studied, with grain marketing bringing in 23 percent, and custom services 11 percent. The grain-marketing equipment was used in this function for the equivalent of about 50 working days annually. An analysis of the trade areas served by these elevators showed that farmers patronizing the elevators usually traveled an average of about 7 miles to reach them.

Most of the elevators studied were located within 5 blocks of the center of town. The sites varied from $\frac{1}{2}$ to 3 acres, averaging $1\frac{1}{2}$ acres. Their location in these congested areas, surrounded by high-value properties, prohibited needed expansion and increased operating costs. The elevator lots were small and narrow, taxes were high, and the disposal of wastes created a problem. The original structures were built between 1880 and 1948, all of them along spur tracks. However, the lack of sufficient space adjacent to the rail spurs made it necessary for some elevators to locate subsequent storage buildings away from the tracks. Space in these buildings often was inadequate, and the poor arrangement of structures and equipment hindered the efficient use of labor.

The most essential equipment for receiving and shipping grain included: (1) Truck scales for weighing; (2) one or more grain receiving pits; (3) a hoisting device to dump truckloads of grain; (4) one or more conveyors to carry grain from pits to desired locations in the elevator; (5) a corn sheller; (6) one or more vertical conveyors (legs) to elevate grain to upper floor levels; (7) a cleaner to separate foreign materials from grain; (8) a distributor to direct grain to chutes that deliver it to desired locations, such as bins, boats, or rail cars; (9) bins for storage, mixing, and turning; and (10) a rail spur. Elevators performing custom services required additional equipment, including grinders, corn crackers and cutters, feed mixers, hopper scales, seed samplers and treaters, and grain graders. Still other facilities, needed by those elevators selling side-line merchandise, consisted of storage space for feeds, seeds, coal, farm machinery, fencing, and other farm supplies.

The major defect in the operation of the grain-handling equipment was lack of coordination in the capacities of the individual pieces of equipment moving the grain from dump pits through the elevator to rail cars or trucks. Other defects found in elevator operations were lack of adequate power and inadequate safeguards against fire and personal injury.

A new elevator in an area is justified only if it can benefit the area and at the same time be self-supporting. The decision as to whether one should be built will be made largely on the basis of the amount of grain marketing business to be done in order to justify the investment. If an examination of the local area indicates that the proposed elevator will have an opportunity to do grain marketing only, the bushels of grain which can be expected to become available for marketing multiplied by the possible margin per bushel should give an income at least equal to all costs of operation and overhead. If there is a reasonable possibility of performing custom services, the volume of grain available for marketing through the elevator should yield an income equal to at least two-thirds of the total costs, and the custom-service operations should yield an amount equal to the remainder. Potential receipts from side-line merchandising should be disregarded at the outset because its development to a successful point is often the result of many years of pioneering and losses. Therefore the grain-marketing and custom-service operations must support the elevator because it is built and equipped to do these specific jobs.

The amount of storage space to be built into a proposed elevator will depend on the amount of space needed for operating storage under local production and marketing conditions. If the flow of grain from farms to the elevator is such that the volume during the peak marketing periods can be moved through the elevator and on to market without any delays, such as those caused by lack of railroad cars or motortrucks, the storage capacity of the elevator may be kept to the minimum needed for the temporary holding of grain until full carloads of various types, classes, and grades are accumulated for shipment. If the grain can be moved away from the elevator as fast as it is received from farmers, only a small amount of operating storage space will be needed. If the grain is to be put through a drier or fumigated for insect infestation, additional holding and turning space will be needed. The elevators studied in Indiana had little use, and in some cases no use at all, for storage space above that needed for operative storage. Such operative storage needs varied from 10,000 to 25,000 bushels per elevator. This capacity made allowance for the temporary holding of some volume while awaiting the arrival of railroad cars. In areas of unusually high peak loads of grain marketing in a short period of time, a larger amount of operative storage may be needed unless an adequate number of railroad cars or trucks are available to move the grain from the elevator. The local demand for public grain storage should be investigated thoroughly and the possible returns balanced against the costs before such storage space is built into a proposed country elevator.

The capacity of the equipment to move grain from dump pits to trucks or rail cars determines the volume of grain that an elevator can receive from farmers, assuming the availability of adequate transportation to move it away.

In choosing a location for a proposed new country elevator, care should be exercised to select one that is adjacent to a main line railroad and that can be easily reached from any direction by motortruck. Its location should be convenient to customers, yet at the same time be far enough removed from congested areas to make possible the acquisition of the site and the operation of the elevator at a reasonable cost. Adequate power and drainage, and sufficient area for possible future expansion also are important factors to consider.

Since labor usually constitutes more than half the total expense of operating a country elevator, the structures and equipment should be placed on the site in such a way as to utilize labor in the most efficient manner. The main structure should be of concrete, and placed adjacent to the railroad spur. Sufficient additional space should be available on the spur for any buildings that might be needed later for receiving and storing merchandise, as well as for carrying on any types of processing. The office space may be located in one corner of the main structure if the elevator engages in grain marketing and custom servicing only. However, as side-line merchandise operations are added, a larger amount of office space and display and sales room space will be needed. Truck scales should be adjacent to the office so that scale readings may be taken within the office. Because custom-service operations usually require the use of some equipment located within the main structure, the building in which these services are performed should be near or attached to the main structure. The power requirements vary according to the number of units of power machinery installed and the size and operating capacity of such machinery. Generally, a small country elevator performing both grain marketing and custom services would require a minimum of between 150 and 175 horsepower.

In certain areas other essential structures on the elevator site may be a grain drier and a cob incinerator. The capacity of the drier is determined by local conditions with respect to the volume of wet grain to be dried and the amount of moisture in the grain. The concentration of heat in a drier makes it desirable that the drier be located outside the main structure to minimize fire hazards. An incinerator is an economical means of disposing of cobs, husks, dust, and other refuse, unless it is determined that such byproducts may have a profitable market or can be fed profitably to livestock by local farmers or by the elevator management.

FACTORS TO BE CONSIDERED IN LOCATING, PLANNING, AND OPERATING COUNTRY ELEVATORS

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INTRODUCTION

In the crop year 1949 about 2,200,000,000 bushels of corn, wheat, and soybeans were sold by farmers in the United States. A high percentage of this grain moved through an estimated 23,000 country elevators on its way to processors and subterminal and terminal storage facilities. If the marketing margin taken by these country elevators was between 5 and 6 cents per bushel, as was the margin received by the elevators included in this study, their income for the 1949 crop was more than 100 million dollars.

There has been a growing demand for information that will show how to determine the proper location, layout, and size of a country elevator and set forth the operating methods, equipment, and practices that would result in maximum efficiency. Such information is needed by people who desire to build new elevators as well as by operators who desire to make improvements in existing facilities. In order to provide the desired information, this survey of the facilities, equipment, and methods of operation of a representative number of country elevators in the State of Indiana was undertaken. Table 1 shows the capacity of the elevators chosen for detailed study.

Table 1.--Elevators studied, by amount of storage capacity for bulk small grain, ear corn, and bagged goods

Elevators studied (Number)	Rated storage capacity 1/	Storage capacity: Bulk small grain: rated capacity — Average per unit	Storage capacity: Ear corn — Average per unit	Storage capacity: Bagged goods — Average per unit
	Bushels	Bushels	Bushels	Tons
4	11,000 - 15,500	12,937	500	137
5	19,000 - 27,731	21,946	2,040	144
3	30,000 - 40,000	33,340	21,000	52
3	50,000 - 70,000	58,333	0	225
3	80,000 -100,000	88,333	0	1,673

1/ The term "rated storage capacity" is used to indicate the maximum bushels of grain the elevator will hold in its grain-storage bins.

Country elevators in Indiana were chosen because within that State there is production of considerable quantities of grain for livestock feeding and of wheat, soybeans, and some corn for cash sale. In this study the term "country elevator" is used to denote a facility specifically designed, constructed, and used as an assembly point for whole grain from farms, and equipped to handle and move grain to points farther along in the marketing channel. The elevators included in this study were selected from a 35-county area, in which 394 country elevators were located. The distribution of the elevators by rated storage capacity is shown in figure 1. From this figure it will be noted that the majority of the elevators in the selected area had a rated storage capacity of less than 20,000 bushels, and that only 9 had a capacity of more than 100,000 bushels.

These elevators were examined with respect to location; size and type of physical structure and facilities; capacity to receive, handle, store, and ship grain; how and in what volume they carried on custom-service operations for farmers; and various types and volumes of side-line enterprises. In order to describe their operations more adequately, an analysis was made of receipts, expenses, and incomes from specific sources, and, to the extent possible, an evaluation was made of the management and operation of the elevators as business units.

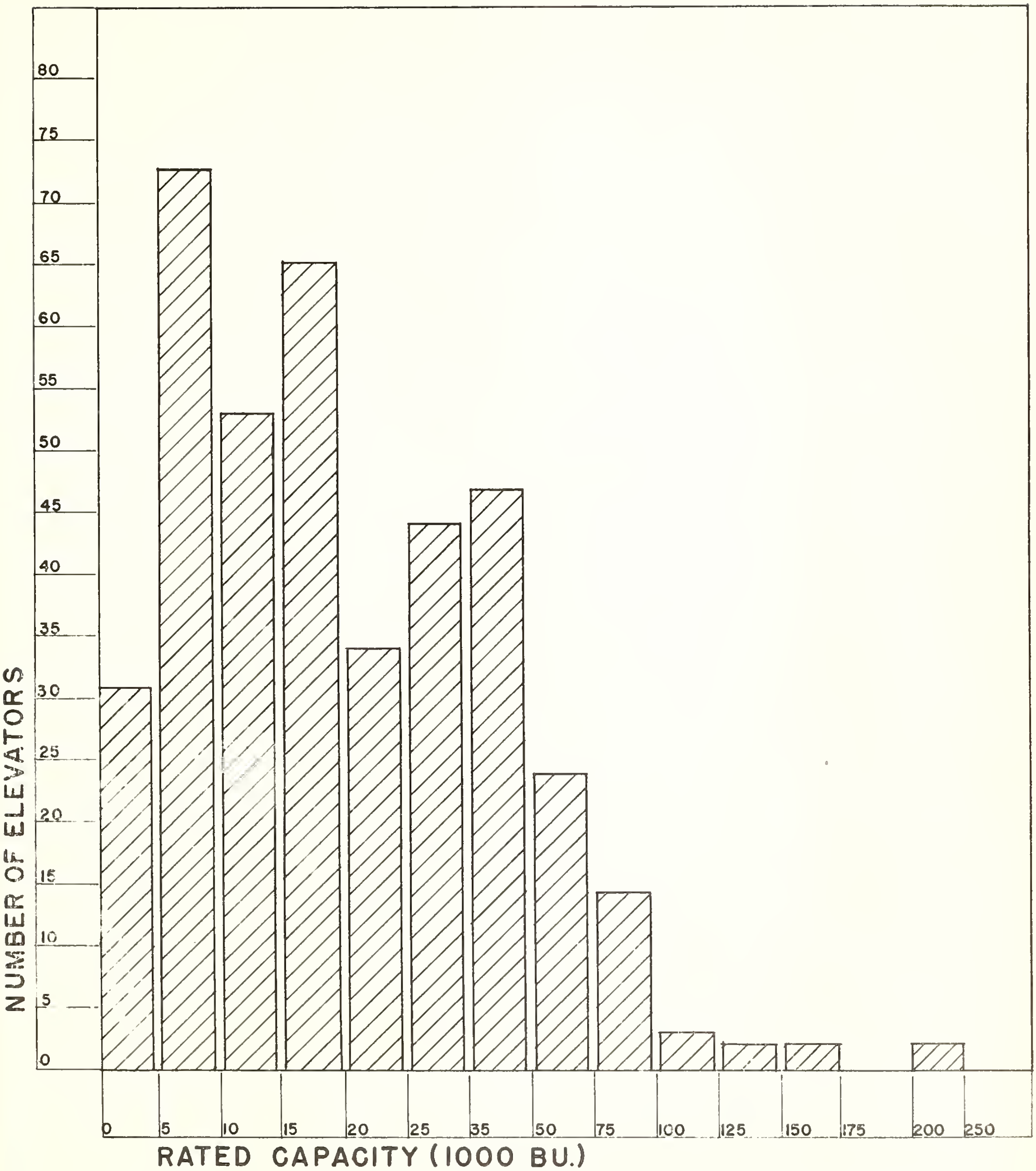

Figure 1.--Rated capacity groupings of country elevators in 35 Indiana counties.

SERVICES PERFORMED BY ELEVATORS

The country elevators studied in Indiana were primarily concerned with: (1) Receiving and shipping grain purchased from farmers, (2) selling services to farmers, and (3) selling merchandise to farmers and other people in the area.

Receiving and Shipping Grain

In each case the elevator structure was built and equipped for the purpose of receiving grain and moving it on to other points in the marketing channel. These elevators bought from farmers mainly corn, wheat, soybeans, and oats, but also some quantities of barley, rye, and grain sorghums as well as grass, legume, and other seeds produced in the local areas.

All grains were received and shipped in bulk. The grain was weighed, graded, and dumped from the farmer's truck or trailer into elevator dump pits. From the dump pits it moved through cleaners into storage bins or directly into railroad cars or trucks for shipment. Ear corn was shelled, and the cobs and husks cleaned from the grain in the process of movement. All of this grain movement was carried on by means of mechanical equipment, with little manual labor except in the operation and maintenance of the equipment.

In the elevators studied, the gross income received from the marketing of grain was 23 percent of the total gross income from all sources.

Performing Custom Services

The term "custom services" is used to denote a group of services, performed for a fee primarily for farmers, which require elevator labor and equipment, such as grinding grain, shelling, mixing, cleaning, and drying, but which do not include the direct sale of merchandise. Since the elevators were located where livestock feeding on farms was a major enterprise, the grinding and mixing of feeds were important services by them. Poultry, dairy, and hog feeds were ground and mixed at the elevator, the farmer usually bringing the grains for mixing with protein ingredients to be supplied by the elevator. Other services for farmers by these elevators included corn shelling, seed and grain cleaning and treating, grain drying and storing, and hauling grain and merchandise between the elevator and the farm on elevator-owned trucks.

The gross income received by elevators for custom services was 11 percent of the gross income from all sources.

Grinding and Mixing

Corn and oats were the principal grains ground in the elevators studied, the volume of corn ground being several times that of oats.

Many farmers, especially those with dairy herds, took a mixture of ear corn and oats to the elevators for grinding. To the ground corn-cob-oats mixture was added a high protein concentrate, and all were mixed together to make a dairy ration of desired proportions. Fifteen units performed grinding services, at hourly capacities of $1\frac{1}{2}$ to $5\frac{1}{2}$ tons, or an average of $2\frac{1}{2}$ tons. The service charges ranged from $2 to $3 per ton and averaged $2.45. The process of grinding required the time of one man, but since mixing was often closely tied in with the grinding process the labor of more than one man sometimes was required, the number depending somewhat upon the type of equipment. Grinding and mixing feeds were among the most popular and advantageous services offered to farmers and accounted for a considerable part of elevator income, and in a majority of the elevators studied was second only to income from marketing grain.

Corn Shelling

All elevators did custom shelling of corn. Hourly capacities for this operation ranged from 750 to 1,000 bushels, and averaged approximately 900 bushels. The shelling operation required a major part of one man's time during the process. Service charges ranged from 1.5 cents to 3.6 cents per bushel, and averaged 2.75 cents. Revenue from this service accounted for a considerable portion of the gross income in all units. Ear corn, brought to the elevator for sale, was shelled and sold as shelled corn. Corn was also shelled and ground for feed mixes for hauling back to the farms.

Grain Storage

Farmers did not usually store grain in the country elevators studied. Most of them sold cash grains at harvest time and stored their feed grains on their farms. The storage of soybeans for processors was the principal use made of storage space, the space being so used late in the soybean harvest time (usually for only a few months) until the beans could be moved through processing channels. Some large producers of soybeans held their beans in storage space in the elevators for later marketing. Elevator managers nearly always had storage contracts terminate by June 1 at the latest so that bins would be empty when the new marketing season began. This was particularly true of smaller elevators.

In 1949 only about 14 percent of the storage space in all elevators was used for public storage during a part or all of the storage season. This service was confined mostly to those elevators having larger capacities.

All the elevators studied charged $1\frac{1}{2}$ cents per bushel per month for storage. This rate usually included insurance charges. Some elevators included cleaning and turning services in the storage charge, whereas others charged $\frac{1}{2}$ cent per bushel for each of these services.

In general, the elevator income derived from the rental of storage space was rather small. Storage space in the elevators was used primarily for operative storage 1/ when the car supply did not keep pace with deliveries.

Cleaning

More than half of the elevators gave service on cleaning small seeds. The average hourly capacity for this operation was 8 bushels. During the time a seed cleaner was in operation, the time of one man was required.

Eleven units did custom cleaning of farm grains, such as wheat, beans, and oats, and had an hourly capacity for cleaning that ranged from 40 to 2,000 bushels. Although the average charge was 5 cents per bushel, in the majority of these units the cleaning service was not a source of appreciable revenue. Only four of the units gave considerable emphasis to cleaning services, and their annual revenue from this source was substantial.

Drying

Only one elevator studied did custom grain drying (mostly corn) for farmers. Four other elevators were equipped with driers, but dried grain only on their own account. In 1948 the one elevator that offered this service to farmers custom-dried about 14,200 bushels from which a gross income of approximately $850 was derived. The manager of this unit estimated the average cost for drying to be approximately 6 cents per bushel. Other managers estimated the cost of drying to be about 1 cent for each 1 percent decrease in moisture. Elevators of small capacity had no equipment for drying grain. The manager of the elevator that dried 14,200 bushels of grain for farmers in 1948 estimated that a total of 50,000 bushels was dried in 1949 for farmers and for the elevator account, but the other four managers could give no estimate of the volume dried on their own account during that year. One of the four, however, reported that the volume he handled was very small.

Four of the five driers were installed during the period 1942 to 1948, and the other at the time the elevator was constructed, which was before 1940. All driers were reported to have given satisfactory service but were of small capacity. The amount of grain dried and the amount needing drying in any one year depended upon: (1) The amount of rainfall and other weather factors in the harvest season, (2) the ability of harvesting machinery to handle high moisture grains, (3) the desire of farmers to finish harvesting before maturity for fear of impending weather damage, and (4) inadequate storage facilities on farms.

Trucking

More than half the elevators hauled grain, feed, seed, coal, and fertilizer as a service to customers. The charge ranged from 2½ cents

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1/ The term "operative storage" is used to denote the amount of storage space needed to carry on day-to-day elevator operations.

per bushel on oats to a maximum of 6 cents per bushel on other grains. The majority of the elevators doing this service were in the smaller capacity groups. The average rates for coal and feed hauling were $1.65 per ton. It was estimated that about $1\frac{1}{2}$ man-hours were required on the average per hundred bushels of grain hauled. Some units made allowances when merchandise was called for by customers.

Selling Side-line Merchandise

There was considerable variation in the elevators included in this study in the items of merchandise sold to farmers and to the public. The three most important side lines in the merchandising field were the sale of coal, bagged feeds and feed ingredients, and seeds. Nearly all of the elevators studied sold these items. Other side lines included fuel, oil, hardware, livestock and poultry-feeding equipment, livestock minerals and medicines, farm machinery (both new and used), lumber, fencing and posts, water tanks, insect sprays and fungicides, and other farm supplies. The gross income received by elevators from the sale of side-line merchandise was 66 percent of the gross income from all sources.

DESCRIPTION OF ELEVATOR TRADE AREAS, SITES, AND STRUCTURES

Area Served by Elevators

The area from which farmers bring their grain to an elevator is usually referred to as the trade area of that elevator. The farmers patronizing the elevators studied normally traveled an average of about 7 miles to reach them. During peak marketing seasons some elevators received grain from more distant farms. This indicated that during such seasons some farmers hauled their grains greater distances, seeking out the elevators rendering the most prompt and efficient service, and possibly paying higher prices. During peak marketing seasons the overlapping of areas from which the elevators drew grain indicates active competition between elevators for this type of business. Peak marketing season business done by most elevators came from an area about 50 percent greater than the area from which business was normally derived.

Production in the areas served by these elevators varied to some extent because of soil types and other factors. Corn and oats were the principal feed crops grown; wheat and soybeans, the major cash crops. The standard crop rotation was corn and soybeans and wheat and oats. Legume hays occupied an important place in the rotation. A high percentage of the total production of wheat and soybeans moved off the farms through elevators. Corn and oats were primarily produced as crops to be fed on the farms, only the yearly surpluses being offered for market. The concentration of livestock, mainly hogs and cattle, was high per acre of cropland, and the receipts from hogs and cattle marketing made up a high percentage of the total farm incomes. Certain elevators were in areas where the production of corn as a cash crop for market was common practice. Because of the type of farming in the respective areas, corn comprised the greatest volume of the grains moving through the elevators, wheat or soybeans being next in importance.

Although the elevators having the greatest storage capacity did the greatest amount of grain marketing, as shown in table 2, many having a comparatively small storage capacity received a much greater amount of grain from farmers than some having a larger capacity. Certain elevators were so situated in relation to competing elevators that they had an advantage with respect to patronage from farmers.

Grain producers delivered in their own trucks approximately 62 percent of all grain received by the elevators. Cartage companies hauled about 25 percent, and elevator-owned trucks hauled 13 percent. In the areas marketing larger quantities of grain the percentage of grain hauled from farm to market by cartage companies was greater than in those where the volume sold was smaller. Grain elevators that carried on custom services for farmers tended to haul more grain in elevator-owned trucks than did elevators whose services were more limited.

Table 2.--Relation of capacity of elevators to trade area and volume of business

Elevators in group (Number)	Average rated capacity	Average volume marketed	Average grain marketed per bushel rated capacity	Average number of farmers from whom grain was purchased	Average volume of grain marketed per customer
	Bushels	Bushels	Bushels	Number	Bushels
4	12,900	198,500	15.39	383	518
5	21,900	239,500	10.94	219	1,093
3	36,700	240,500	6.55	131	1,836
3	58,300	225,000	3.86	337	668
3	88,300	454,000	5.14	471	964
Average 18 units	43,600	271,500	6.23	288	943

Sites and Structures

The sizes of the sites upon which the elevators were located varied from ½ to 3 acres, the average size being 1½ acres. Four of the elevators on the larger sites owned adjoining land for possible future expansion. The width of sites varied from 90 to 255 feet, the average width being 177 feet. The average length was 330 feet and varied from 160 to 600 feet. Each elevator was located on a railroad, and the tracks usually were along the longest side of the site, in most instances being parallel to the main line of the railroad. There were streets or highways running along one or more of the other sides. The spur track side of the site usually was not used as a street.

The average age of the original structures of the 18 elevator units chosen for this study was approximately 40 years. The dates of construction of the facilities ranged from 1880 to 1948. Nine elevators were originally constructed exclusively for the storage of grain, 8 for grain storage and custom processing, and 1 for limited grain processing. Fourteen were built of wood and 4 of concrete. Two of the 18 were constructed to replace structures that had burned. 2/ Some structural and equipment improvements had been added to each unit since the original facilities were built; these included elevators built since 1945. Of the 18 elevators studied, 14 were located within 5 blocks of the business center of their respective towns.

The elevator structure in which the grain-handling and elevating equipment was housed was located along the spur track. The size of these structures ranged from 24 to 40 feet wide, from 30 to 100 feet long, and from 60 to 151 feet high. The smallest structure was 27 by 30 feet and the largest 40 by 100 feet. The most essential facilities for grain marketing were: Wagon or truck scales for weighing; one or more grain receiving pits; a hoisting device to dump wagonloads and truckloads of grain; one or more conveyors (drags) to carry grain from grain pits (dumps) to desired locations in the elevator; a corn sheller; one or more vertical conveyors (legs) to elevate grain to upper floor levels; a scalper (cleaner) to separate foreign materials from grain; a distributor to direct grain to chutes that delivered it to desired locations, such as grain bins, boats, or rail cars; grain bins for storage, mixing, and turning; and a rail spur to hold grain cars for loading. Above the bin-top level is a structure called the head house, in which the elevator leg head and distributor are located. All grain going to the main storage bins was elevated to the head house and distributed to the bins usually by chute from the distributor. (See figs. 2 and 3.)

Six of the structures had platforms approximately 8 feet wide running along the side of the main structure next to the spur track, thus making the center of the spur track approximately 16 feet from the structure. The platforms were at car-floor height, about 48 inches above the top of

2/ One of the elevators studied has since burned.

Figure 2.--Country elevator of small grain-storage capacity showing: (1) Feed-storage structure, (2) drive and entrance to elevator driveway, (3) attached office, (4) storage space for farm supplies, (5) head house over small grain bins, (6) concrete grain bins, and (7) dust collector above custom-service grinding and mixing work floor.

Figure 3.--Country elevator of large grain-storage capacity showing: (1) Detached office, (2) truck scales, (3) drive from truck scale to elevator driveway and dump pits, (4) detached grain drier, (5) cob chute, (6) incinerator, and (7) grain bins of 100,000-bushel rated capacity.

the rails, and on the same level as the main floor of the elevator structure. The older type of elevator structure usually had no platforms, so on 12 of the elevators the center of the spur track was approximately 8 feet from the side of the structure. In the older elevators the driveway and door into which the truckloads of grain were moved for dumping into the dump pits was located in the main elevator structure. In the elevators built in more recent years the driveway to the dump pits entered a shed-roofed structure, mainly of one-story height, built onto the main elevator structure on the side opposite the spur-track side, the dump pits therefore not being located in the main elevator structure (figs. 4 and 5). The width of this shed-roofed structure, including a driveway 10 feet wide over the dump pits, varied from 24 to 40 feet. The structure usually extended the length of the elevator building and also housed the feed-grinding and -mixing equipment, the bagged feed ingredients, and the mixed feeds. The side of the feed-mixing shed opposite the dump pits usually had platforms at floor-level height varying from 4 to 10 feet in width and from 20 to 36 inches above the driveway.

All elevators had one or more grain chutes through which grain moved by gravity into grain cars. They extended from near the top of the grain bins, below the head house, to the car level on the spur-track side of the elevator. On other sides of the elevator structure one or more metal chutes led to cob-storage bins or cob-storage houses located near the elevator, to dust collectors outside the elevator structure, or to a cob and trash incinerator. In some elevators outside grain chutes led from the main structure to the feed-grinding and -mixing room.

Some elevators had the feed-mixing and merchandising-storage structure along the railroad spur track at the end of the main elevator structure with car-floor height platforms on the same level as the work floor so that incoming merchandise and bagged goods could be unloaded from cars and moved to storage on the same level.

The offices of 13 of the 18 elevators studied were located in detached structures from 50 to 150 feet from the main elevator, but the offices of the remaining elevators were in structures attached to the main building. The driveway from the street led to the office building and the platform truck scales, which were on one side of the office building. Three elevators had two platform scales, one on each side of the office structure. The driveway and parking area around the office and elevator had a rock or gravel surface. Locations of weight-recording beams of the truck scales were inside the office. Offices ranged in size from a space large enough for a desk and two or three chairs to a space in which three or four desks and one or more filing cabinets could be placed, with working room for three or four employees and with a display and customer counter and customer waiting space. Each office had a telephone, radio, and more than half of the offices had a communication system with key work centers of the elevator. (fig. 6).

Figure 4.--When this country elevator was originally built, a lean-to shed was placed over the grain dump drive next to the main elevator structure. Later, additions for custom services, such as the feed-grinding and -mixing room, were added including a roofed custom-service driveway.

Figure 5.--At the time this structure was built, the office was located in one corner. The grinding and mixing room now occupy this space. The delivery of bulk ground grain to a customer's trailer is shown.

Figure 6.--From the new detached office, the manager, through the large window, can observe area activities at all of the structural facilities on the site.

The number of structures, in addition to the foregoing, that were located on the elevator site was determined by the kinds of side-line enterprises carried on by the elevator. The specialized seed business and the lumber and building material business, if carried on in substantial volume, usually required special buildings on the site for those purposes.

Some elevators had car-floor height, uncovered platforms along the spur track for the unloading and loading of farm machinery, fencing, and other heavy merchandise (fig. 7). The petroleum products business usually required specialized structures located completely away from the main elevator structure.

Figure 7.--Concrete platform at car-floor height, with ramp, increases efficiency in loading and unloading items connected with side-line merchandising.

EQUIPMENT AND FACILITIES USED BY ELEVATORS

The methods of performing mechanical operations varied widely, even though the end products were quite similar. No attempt has been made to describe isolated or uncommon types of equipment, or to make sharp definition of improved mechanical methods used in a particular elevator as compared with the somewhat unimproved mechanical methods found in others. Several factors were responsible for the use of these types of equipment, such as types of services requested by farmers, and the individual ability and ingenuity of managers, either past or present, in making elevator operations more efficient.

In Receiving and Shipping Grain

All country elevators studied had similar facilities and equipment for handling grain. The principle developed originally for the handling of grain--elevation into vertical bins--is essentially the system in use today, although improvements have been made in the mechanical efficiency of the equipment used for this purpose. The paragraphs below describe the standard facilities and equipment in their normal sequence of use by country elevators in receiving bulk grain from farmers and shipping it to subterminal or terminal elevators (table 3 and fig. 8).

Motortruck Scale

Motortruck scales are used to weigh incoming and outgoing vehicles loaded with commodities for sale and purchase by the elevator and its customers. Each of two elevators had two sets of motortruck scales, and 16 elevators had one each. All the scales were adjacent to or along one side of the office, the scale beam being within the office. The distance between the scales and the dump pits ranged from 15 to 160 feet. After operating for many years each with one small scale located about 20 feet from the dump, the elevators with two platform scales installed the second scale farther from the dump pits than the original scales were.

The truck scale platforms ranged from 8 to 12 feet in width, and from 16 to 45 feet in length. Nine of the scales and platforms were under roofs, that had a clearance ranging from 12 to 18 feet. The average approach grade to all scales was approximately 5°, ranging from 2° to 10°. The average width of the approach drive was about 13 feet. The weighing capacity of the scales ranged from 8 tons to 50 tons and averaged 25 tons per scale. Scales were always installed in a pit, usually of concrete, ranging from 3 to 6 feet in depth below the platform level. All scale pits were accessible through the basement of the office or of the elevator structure.

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Table 3.--Equipment in common use in country elevators doing grain marketing, custom servicing, and side-line merchandising

Kind of equipment	Operating capacities (hourly or filled capacity) 1/			Horsepower used 2/		Units usually installed (range)
	Unit	Small capacity	Large capacity	Small capacity	Large capacity	
						Number
Truck scale	ton	10	40	0	0	1 - 2
Hoisting device	do.	10	25	$2\frac{1}{2}$	5	1 - 1
Grain pit	bushel	100	1,500	0	0	2 - 6
Grain drag 3/	do.	100	2,500	2	2/ 75	2 - 3
Sheller	do.	350	2,000	20	2/ 50	1 - 1
Elevator leg	do.	200	600	5	2/ 40	2 - 3
Cleaner	do.	300	2,200	3	10	1 - 1
Drier	do.	150	300	5	10	0 - 1
Cob blower	do.	200	2,000	5	$7\frac{1}{2}$	0 - 1
Automatic scale	do.	800	2,500	0	0	0 - 2
Hopper scale	do.	4/ 100	1,300	0	0	0 - 1
Car-leg grain blower	do.	700	1,500	5	10	0 - 1
Dust collector	ton	$\frac{1}{4}$	5	2	3	1 - 2
Manlift	man	1	1	0	3	1 - 2
Grain grinder	bushel	50	1,500	25	100	1 - 2
Corn cracker	do.	100	250	5	$7\frac{1}{2}$	0 - 1
Feed mixer	do.	20	165	3	30	1 - 3
Coal toter	ton	15	50	3	5	0 - 1
Coal conveyor	do.	20	60	$1\frac{1}{2}$	5	0 - 1

1/ Many of the modern types of operating machinery and equipment are manufactured and installed for operation at varied speeds, therefore making speed adjustments possible.

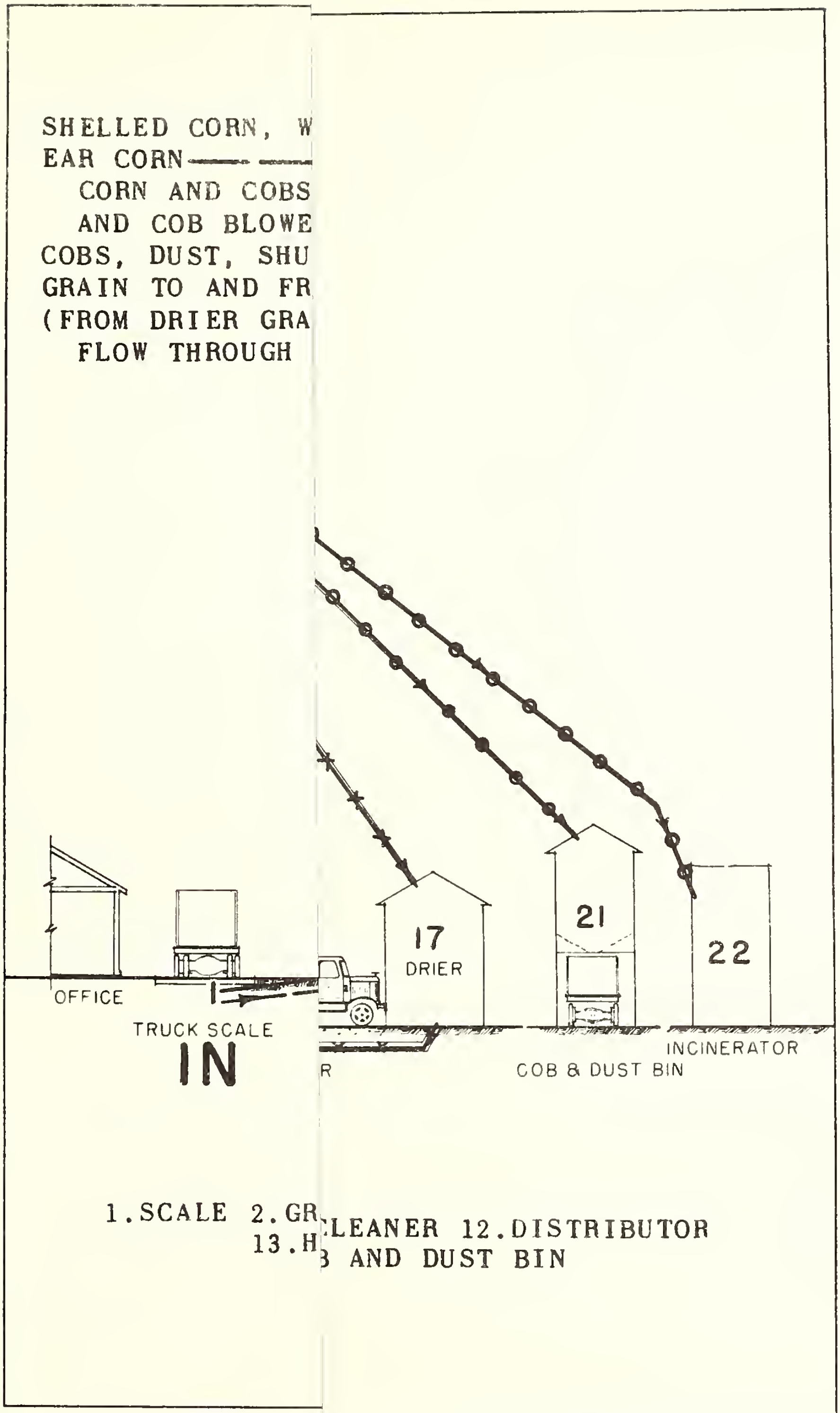
2/ One motor was often installed to combine power for the drag with the elevator leg, sheller, or other equipment directly related to the drag.

3/ The capacity of gravity drags was usually limited only by the capacity of the equipment fed by the drag. A lead-off conveyor or drag may be installed for special types of operation.

4/ Capacity of hopper.

Grain Moisture Meter and Kettle Tester

All elevators studied used electric moisture meters for determining the percentage of water in grain. They were of the simpler type, whereby the grain sample could be rapidly tested, but were considered reasonably accurate. These meters, permanently located in the elevator office, required a table area of about 4 square feet. A small sample of grain was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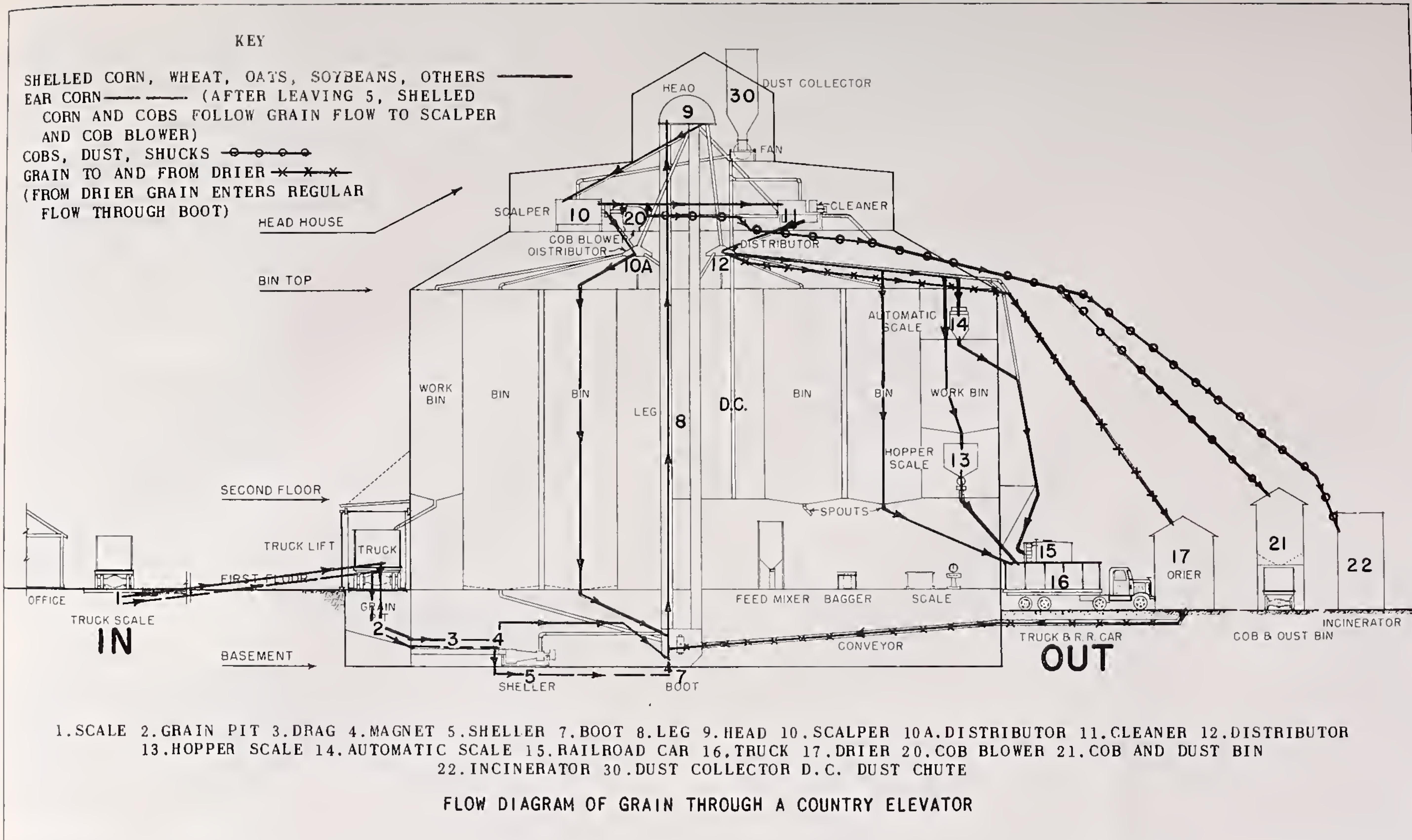

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Figure 8.--Flow diagram of grain through a country elevator in grain marketing.

taken from each load for testing, and less than 1 minute was required to run a sample through the meter. Only whole grains could be tested.

A 2-quart kettle tester, a strike-off bar, and a graduated scale beam were used by every elevator studied for determining the weight of a given volume of grain, and to assist in establishing the grade and price of the grain purchased.

Grain-Receiving Pit or Grain Dump

A grain-receiving pit, usually called a grain dump, is a walled enclosure, constructed like a hopper, with a slanting bottom so that grain entering the top flows to the bottom by gravity. Grain dumps were always located beneath the floor of the driveway, going through or being immediately adjacent to the main elevator structure. Most of the dump pits were constructed of wood, either cribbed or studded, but two were of concrete. The pits were covered with heavy timbers or concrete, of sufficient strength to carry loads up to 25 tons, the cover being on the level of the elevator driveway. In the pit cover a dump grate was built of heavy metal bars, placed at close intervals, through which grain passed into the pit.

Each of the elevators had two or more grain dumps, the number per elevator ranging from two to six and the average being three. Dump pit capacity averaged about 300 bushels and ranged from 50 to 800 bushels. In most elevators grain dumps of comparatively large capacity had been built for the exclusive handling of ear corn, which required a special type of grate. These pits were usually connected directly to a corn sheller by gravity or mechanical drag. As a service to farmers, some elevators had installed dump pits, usually of small capacity, for the receiving of seed grains for cleaning. Elevators doing a large amount of feed grain grinding and mixing usually had an extra dump pit, mainly to facilitate this operation, whereas other pits were being used for handling grain for marketing.

Hoisting Device

The hoisting device is an electric-powered mechanism used to elevate the front end of trucks so that the bulk grain flows by gravity from the rear of the truck through the dump grate into the pit (fig. 9). It was located in the elevator driveway over the dump pits and usually moved on a permanently installed horizontal track so that all dump pits and different lengths of trucks could be serviced by one hoisting device. Steel cables winding around a drum on a powered steel shaft lifted the trucks either by hooks attached to the front of the truck or by lifting a cradle onto which the front wheels of the truck were driven.

Four elevators were equipped with cradles at the end of the cables, and 16 elevators used only hooks. Two elevators each had two hoisting

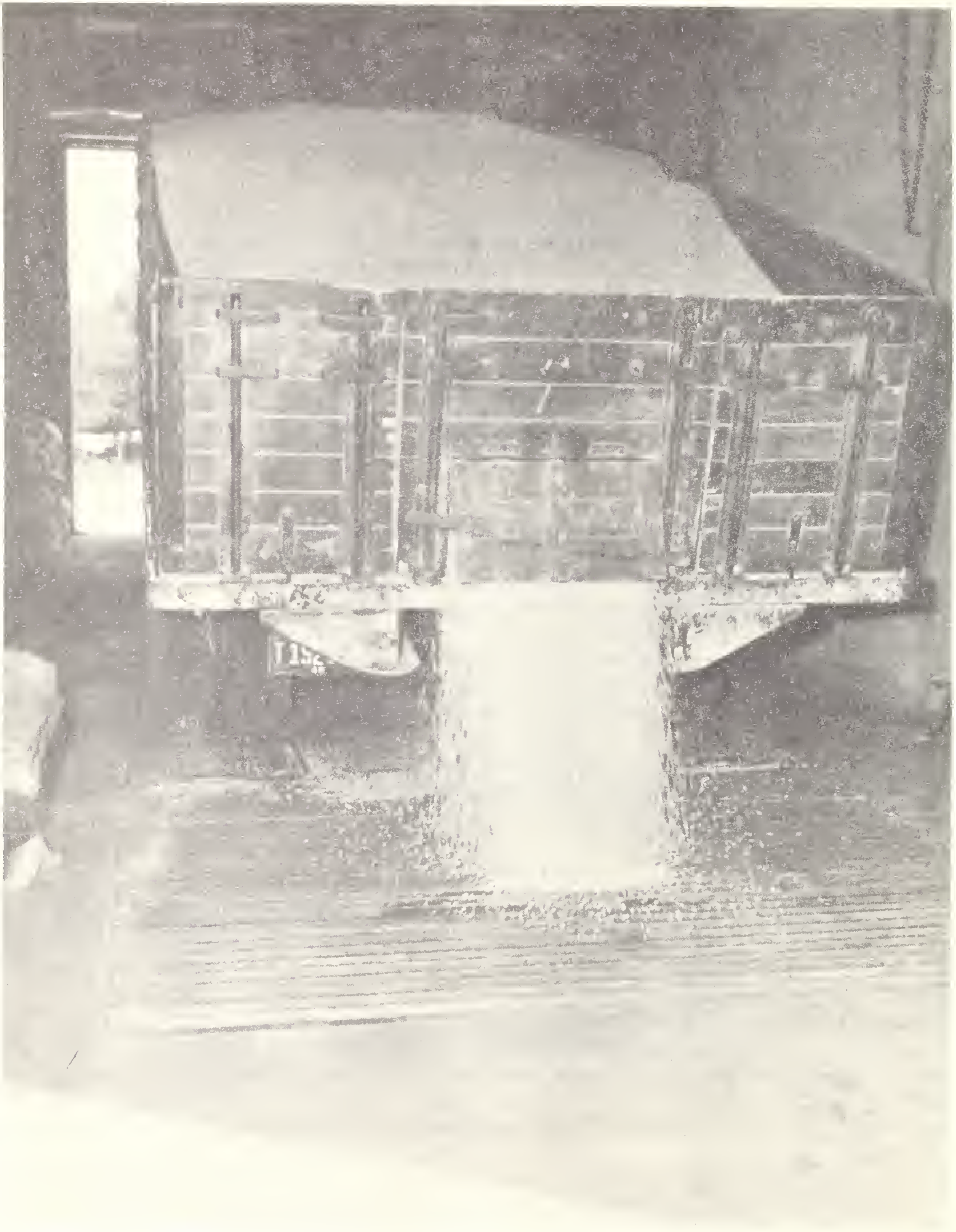

Figure 9.--Front end of truck is lifted by hoisting device to unload soybeans through dump grates into grain-receiving pits.

devices which permitted the unloading of two trucks at the same time. Hoisting capacity ranged from 10 to 25 tons; the motors ranged from 3 to 5 horsepower.

Conveyor or Drag Line

Either power-driven or gravity-type conveyors are used to move grain from one point to another. The power-driven type consists of chain drags, [3] screws, and belts, whereas the gravity-type consists of chutes and spouts. The elevators studied had a total of 34 conveyors powered by chain drags, 1 by a screw drag, and 1 by a belt, and they had 13 gravity chutes. No elevator had less than 2 drags, and 2 elevators had 4. Each dump pit for grain had a drag of some type. About half the drags were for ear corn, and half were smaller dimension types for handling small grain and shelled corn. The horsepower used on the powered drags averaged 6.2, and ranged from 1 to 20. The hourly capacity ranged from 100 to 6,000 bushels, the average being 1,250 bushels. In some cases, the power for the drag was shared by the piece of equipment served by it, such as the elevator leg.

Magnet and Magnetic Separator

In order to extract metal from grain before it reaches equipment where it might do a substantial amount of damage, large magnets or magnetic separators were installed, usually at the point where the grain leaves the drag. Most elevators had additional magnets to extract any metal loosened or broken from the moving parts of the equipment while in use. Of the 18 elevators, 16 had at least 1 magnet or magnetic separator, and most of them had more than 1. Five elevators serviced their magnets daily, whereas other elevators had types of separators that needed service only weekly or monthly. At each elevator an average of about 1 pound of metal was extracted from whole grains or ground and mixed materials in 1 day's operation.

Corn Sheller

In Indiana, no ear corn moves into commercial channels beyond the country elevator. Consequently, all corn shipped to terminals, subterminals, processors, and millers was shelled either on the farm or at the elevator. Some farmers own corn shellers with a small hourly capacity of 100 to 200 bushels. In some surplus corn areas portable corn shellers for hire, with hourly unit capacities of from 800 to 1,200 bushels, are owned by individuals, a group of farmers, or an elevator. These shellers may be used to shell corn for delivery to elevators.

3/ In Indiana, the word "drag" is used to indicate the equipment which moves grain from the bottom of the dump pits to the leg boots, corn shellers, or other equipment in the immediate area. In some cases it also was used even if the grain moved from the dump pit by gravity chute.

Some of the elevators included in this study, particularly those of smaller rated capacity, did an appreciable volume of corn shelling. Each elevator had one or more corn shellers, all of which were permanently installed. All except one were in the basement. Ear corn moved by drag from dump pits to the sheller.

The average shelling capacity of corn shellers was about 850 bushels per hour, and ranged from 350 to 2,000 bushels per hour. Electric motors furnishing power to these shellers ranged from 20 to 50 horsepower and averaged 27½ horsepower per sheller. One elevator operated an 800-bushel capacity sheller at only 400 bushels per hour because automatic scales, legs, and cleaner were inadequate in size and capacity to handle a larger volume.

Elevator Leg

In an elevator the mechanism to lift grain and other materials to a higher level is called a "leg." All elevators studied used the age-old endless belt method in which buckets attached at regular intervals to a belt moved over pulleys or rollers at the top and bottom ends. All legs were permanently installed within or as a part of the permanent elevator structures. At its base the leg rested upon the leg boot, which served as its support, and the boot pit around the leg boot was the container for the grain or other material to be elevated. Grain or other material was fed into the boot pit by drag from the dump pits, corn sheller, or other equipment. Buckets on the belt picked up the grain or other material and carried it upward to the leg head, located in the head house, where the buckets discharged their load before starting their descent. Usually the elevator leg was near the center of the elevator structure, extending vertically between the grain bins. The endless belt, with buckets attached, was boxed throughout from the leg boot to the leg head. Such boxing on the larger capacity legs averaged 13 by 15 inches, some small legs being 7 by 10 inches. Usually they were made of wood, although four elevators had concrete boxing legs, and one had legs of wood lined with sheet metal.

The lengths of the legs used for filling grain bins and for other normal handling operations varied from 60 to 151 feet, the average being about 75 feet. Each elevator had at least 2 long legs. Some elevators that were specializing in the seed merchandising and cleaning business, or that had a large volume of custom service business, had several legs, usually ranging from 18 to 30 feet in height. One elevator had a total of 10 legs, 4 long legs for the normal handling of grain, and 6 short legs for handling seed, ground feed and grains, and for other service operations.

The long elevator legs had handling capacities varying from 700 to 3,000 bushels per hour and had motor horsepowers varying from 10 to 25. On the average, long-leg independent operation required from 10 to 15 horsepower. The higher powered motors operating the leg also operated another piece of equipment, usually the drag. The capacity of short legs ranged from less than 50 to 300 bushels per hour. Their motors ranged from 2 to 10 horsepower.

Cleaner

The terms "scalper," "cleaner," "recleaner," "garner," and "separator" were often used to designate the equipment used, in addition to the magnet, for the separation of foreign materials from grain. The difference in names for this equipment was associated with the several mechanical methods of doing the cleaning operation. The most common designation used by elevators in this study was "cleaner." This equipment was located in the elevator head and its purpose was to separate sticks, corn stalks, cobs, corn shucks, chaff, dirt, straw, dust, and other foreign material from grains. If the grain handled was to be cleaned, it was spouted directly from the leg head into the cleaner. The most common type of cleaner was equipped with a powered fan, and it utilized screens and sieves with various-sized perforations, the size depending upon the type and quality of the grains being cleaned. The grain was conveyed to the cleaner hopper, and by gravity fell onto the screens and sieves. These screens and sieves were placed off-level, and their shaking motion, back and forth, caused the grain and foreign material to advance downward as it was cleaned. The foreign material was picked up by suction or was blown through metal chutes, either into trucks, storage bins on the ground, or directly into the incinerator. The cleaned grain was conveyed, usually by gravity, to its desired destination.

All cleaners were of the shaker type, had a unit capacity ranging from 500 to 1,500 bushels per hour, and an average capacity of 650 bushels. Motors ranged from 2 to 10 horsepower and averaged 5 horsepower per unit.

Distributor

A grain distributor is a metal device into which grain or other materials are received from the leg head or the cleaner and are distributed to any one of several chutes leading to grain bins, railroad cars, or other equipment.

Grain distributors were located from 10 to 30 feet from the leg head and the cleaner, at a level lower than this equipment but slightly above the top levels of the grain bins.

The 18 elevators had 26 distributors, of which 24 were either manually operated from the workroom floor or from the head house, and 2 were operated electrically. Those elevators having more than 1 distributor usually had installed the second one to service bins and facilities too distant from the original distributor to give good service.

Automatic Scale

The automatic scale is a stationary grain-weighing device, which automatically weighs and records the weights of grain flowing by gravity through its hopper. It is located at a level below the distributor and is used mostly for weighing out grain into rail cars and trucks. In six elevators where automatic scales were located on the first floor, after being weighed the grain had to be elevated to some upper level for loading into cars or trucks by gravity. Ten automatic scales were located near head-house floor levels. The small hopper, having a capacity ranging from 4 to 10 bushels and an average of about 6 bushels, was an integral part of the mechanism. When the weight of the grain in the hopper reached a predetermined amount, the bottom of the hopper was automatically released, the weight was recorded, and the grain was moved out of the hopper by gravity until the hopper was empty. When empty, the bottom moved back into place for receiving more grain, the flow of which had been temporarily stopped by a baffle in the grain spout entering the hopper.

Three elevators had no automatic scales but used hopper scales only. There were 18 automatic scales in the other 15 elevators, one elevator having 2 and another 3. All automatic scales had an average hourly weighing capacity of about 1,550 bushels of corn or wheat, ranging from 1,000 to 2,250 bushels. A scale with a 6-bushel hopper weighed out 1,500 bushels of wheat in 1 hour by tripping about 4 times per minute.

Storage Bins and Cribs for Grain

Storage bins for grain, exclusive of ear corn, occupied a major part of the space within the main elevator structure. Some elevators of more recent construction had bins built adjacent to the main structure. The principal types, materials from which made, and the manner of construction were: (1) Cribbed, usually 2-inch by 6-inch milled lumber securely nailed together horizontally, flat surface to flat surface; (2) studded and shiplapped; (3) poured reinforced concrete; (4) concrete slabs; (5) vitrified tile laid circular fashion; and (6) metal plate or sheet metal on wooden or metal frame. Seventy-nine percent of the bins were constructed of wood and were square or rectangular. Twenty percent were constructed of concrete and 1 percent of vitrified tile, always in a circular shape.

The number of bins per elevator ranged from 8 to 22, the average being 13 (table 4). The average grain storage capacity of the bins in all elevators studied was 2,645 bushels, individual bins ranging from 125 to 8,400 bushels.

Grain bins ranged from 12 to 150 feet in height, the inside dimensions ranging from a few feet to 22 feet in diameter or width. In most elevators, some bins of smaller capacity, ranging from 150 to 500 bushels, were located near the custom service work floor area and were used

Table 4.--Average number of grain storage bins per elevator, type of construction, and average capacity, by groups

Elevators in group 1/ (Number)	Average bins per elevator	Type of construction	Average capacity per bin
	Number		Bushels
4	11	12 studded 32 cribbed	1,130
5	10	10 studded 32 cribbed 6 concrete	1,925
3	10	23 cribbed 8 concrete	2,515
3	17	33 cribbed 15 concrete 3 vitrified tile	2,800
3	19	29 cribbed 28 concrete	4,360
18 elevators	13	22 studded 149 cribbed 57 concrete 3 vitrified tile	2,645

1/ By rated storage capacity as shown in table 1, page 1.

primarily as a source of grain needed in custom-service operations. Some service bins were constructed one above the other. Elevators having circular concrete bins used the interstitial spaces as service bins.

Most of the ear corn brought to elevators was shelled before it was stored. However, 10 of the 18 elevators had ear-corn storage facilities which consisted of cribs with plenty of air vent space. Some cribs were built as a part of the main elevator structure, whereas others were on the site but away from the main structure. Three cribs were constructed of metal, and 9 were wood studded and slatted. Two elevators each used a slatted storage space in the main structure interchangeably for ear corn or for oats. All storage places for ear corn were rodentproof. In slatted wooden cribs quarter-inch mesh hardware cloth was placed around

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the walls, and sometimes the floor was covered with hardware cloth or sheet metal. All cribs, whether of metal or wood, were set on pillar foundations, 1 to 2 feet above the surface of the ground.

The cribs had an average capacity of 1,500 bushels, individual capacity ranging from 525 to 3,100 bushels, and were filled with ear corn by portable elevators, which usually were loaded from the back end of trucks. They were emptied mainly from floor-level doors, with hand scoops, onto portable elevators that conveyed the grain into trucks. In the elevators studied, the only equipment used for handling ear corn was the ear-corn dump, drag, corn sheller, and grinder. Equipment for the handling of small grain was not adapted to the handling of ear corn.

Dust Collector

Dust collection in the elevators studied was accomplished by one or more suction fans, which drew the dust through tightly enclosed chutes from various elevator areas. All but two of the elevators had one or more dust collectors. Some were equipped with high-speed fans, the air chutes leading from the grinder, mixer, corn sheller, cleaner, and other equipment, as well as from open areas in the elevator structure. Dust collectors were usually powered by motors of about 3 horsepower, and were located on the roof of one of the lower sections of the elevator structure. Some elevators with extensive work-floor areas for custom-service operations had a second dust collector to service these areas only. Elevators equipped with high-speed fans for dust collection had a minimum of dust on floors, machinery, equipment, and in the elevator atmosphere.

Dust-Storage Bin

Special bins for dust storage were found in 8 of the 18 elevators studied. Such bins either were built as a part of the elevator structure or were 50 to 75 feet from the structure. Four were built of wood and four were of concrete. All dust-storage bins were constructed so that the bins could be emptied by gravity into trucks by use of hoppers or chutes. The two elevators that did not have dust collectors, of course, had no dust-storage bins. The other 8 elevators blew the dust either into cob-storage bins or incinerators or into the air outside the main structures.

Cob-Storage Bin

The shelling of ear corn was one of the common operations performed by the elevators studied, and storage bins for corncobs and husks were found at 14 of the 18 elevators (figs. 10-A and 10-B). The other 4 elevators either burned their cobs in incinerators or dumped them on the ground near the elevator. One elevator had 2 cob-storage bins, and one had a bin for both cob and dust storage. These structures were also used for corn cobs and other trash. Because of the large amount of corn shelling done in elevators, cob-storage capacity was large, the average bin being

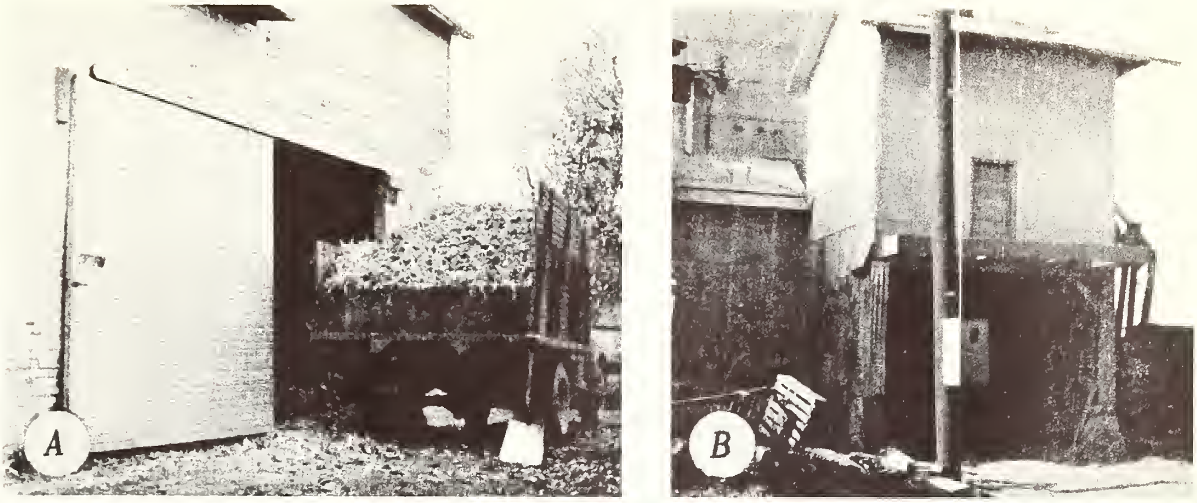

Figure 10.--A,For many years this cob bin was located at ground level. A scoop and man labor loaded the trucks with cobs for disposal outside city limits. B,Later, a cob bin was built, allowing trucks to back in and load direct from the bin. Costs of operation were reduced, but a cob incinerator would further decrease costs when cobs and other wastes are not used as feed for livestock.

about 17 feet square and 27 feet high. In all instances, the bottom of the bin was high enough so that the bin could be emptied by gravity into trucks (fig. 11). Thirteen of the bins were of wood construction, one of concrete, and one of glazed tile blocks. A few were built as part of the elevator structures, but most of them, especially in elevators built within more recent years, were separate structures, from 5 feet to 75 feet away from the main structure. Chutes leading from the elevator head house entered the top of the cob-storage bin.

Cob Incinerator, Chute, and Blower

The cob incinerator was an entirely separate structure built about 60 feet away from any other structures on the elevator site. It was used to burn cobs, husks, dust, and other elevator waste (fig. 12). Only 3 of the 18 elevators had cob incinerators, 2 of these having been installed in more recent years. Cob incinerators were cylindrical structures of concrete or brick, floored with firebrick, lined with firebrick to a height of at least 12 feet from the bottom, and having a diameter of 18 to 20 feet and a height of 30 to 34 feet. Incinerators had no roof but were topped with hardware cloth to control sparks yet allow for open draft, and had openings in the wall at the base to serve as draft vents. They were designed to burn cobs and other waste rapidly with a minimum of smoke.

Figure 11.--For many years the operator of this country elevator used a small fleet of wagons to haul cobs beyond the city limits for burning. Labor for handling was estimated at a minimum of $2,500 annually.

Figure 12---The operator eventually built this smokeless incinerator at a cost of less than 2 years' handling expense under the former method of disposing of cobs and dust.

The cob chute extended from the cob blowers in the head house to within 18 to 24 inches of any opening in the wall of the incinerator at a point about two-thirds of its height. The metal cob chute was 10 to 12 inches in diameter, from 60 to 80 feet in length and extended downward from the head house so that forced air from the cob blower and gravity threw the cobs over the gap into the incinerator. About 3 feet from the lower end of the cob chute a draft trap was built into the chute with the result that, when the cob blower was not operating, back drafts could not carry live embers or sparks through the chute to the head house.

All elevators with incinerators had cob blowers, and one elevator used a cob blower to force cobs and other waste materials into a cob-storage bin. Cob blowers drew cobs and other materials from the cleaner waste discharge and forced them

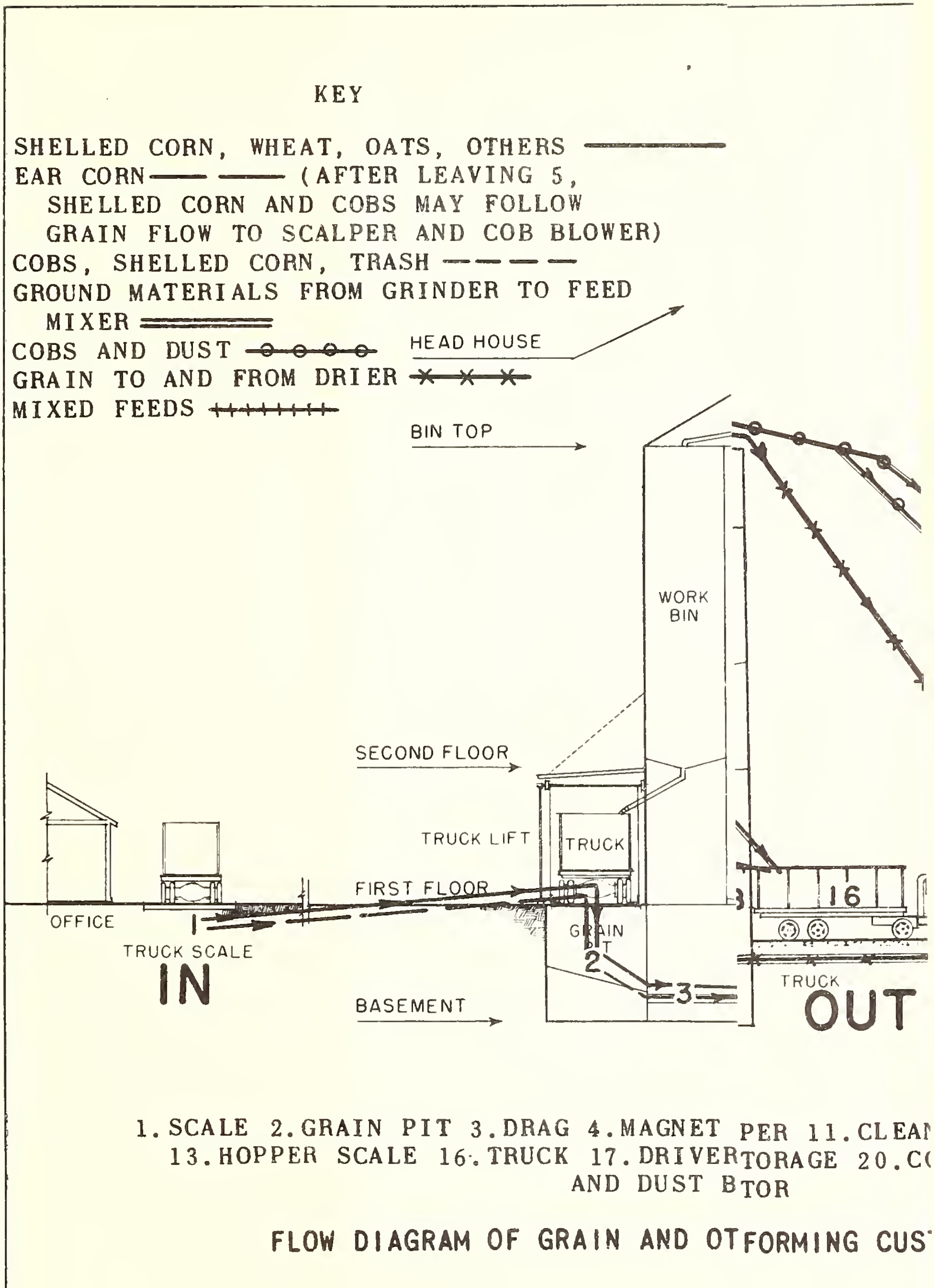

Figure 13.--Flow diagram ng custom servic

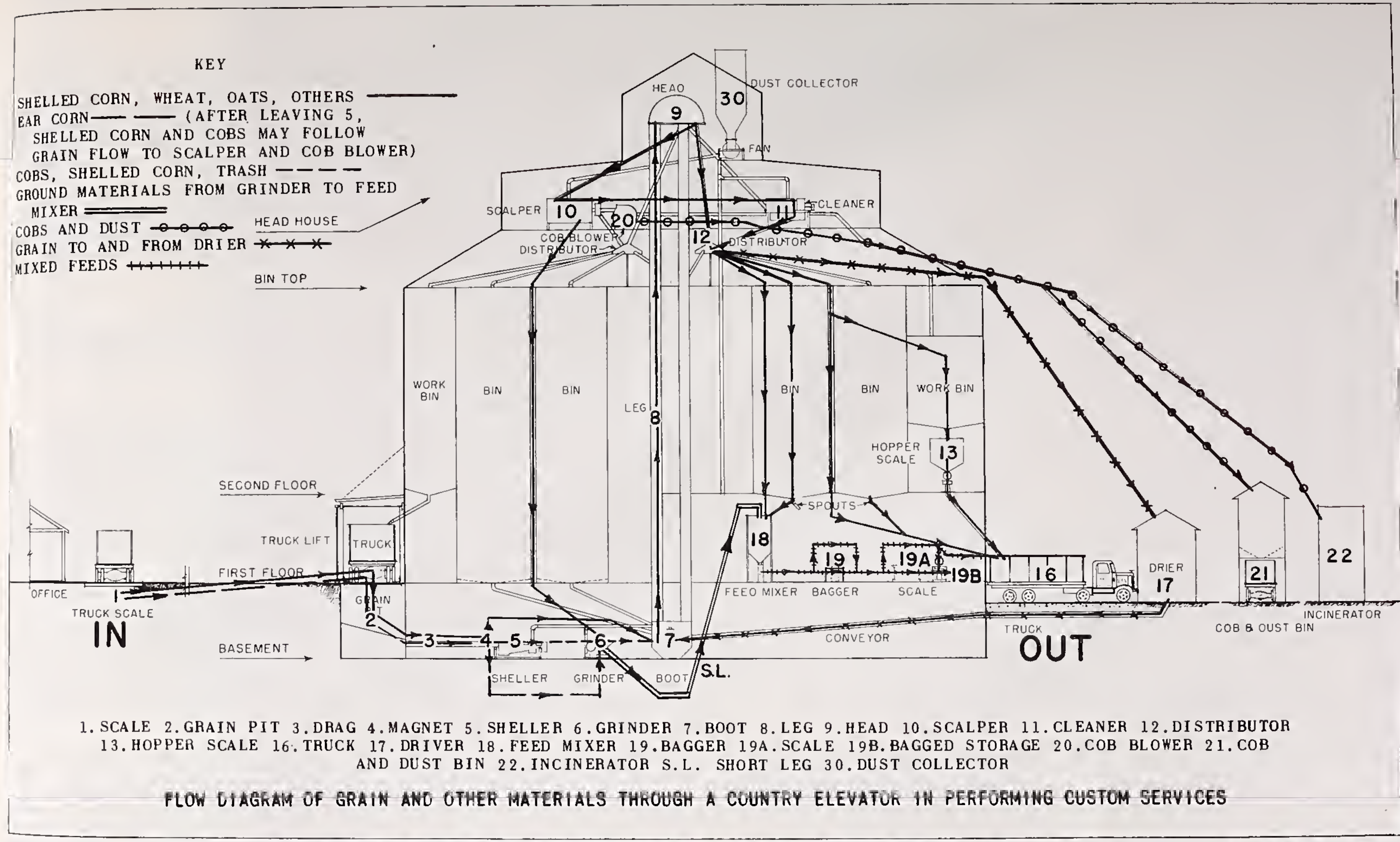

Figure 13.--Flow diagram of grain and other materials through a country elevator in performing custom services.

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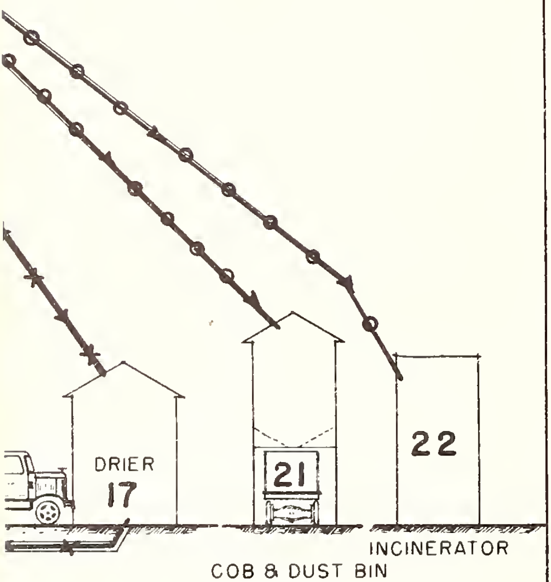

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es.

through the cob chute. All cob blowers were in the head house area, and the blower fans were powered by motors ranging from 5 to $7\frac{1}{2}$ horsepower.

Car Leg Grain Blower

The car leg grain blower is essentially a high-speed exhaust fan, connected with the grain chute, whereby the grain is blown into the railroad car with a speed that allows all areas in the car to be filled without the use of hand labor, except that used to guide the chute from the car-door area. Air draft from the end of the chute blows the grain 25 feet or more so that cars can be loaded from the ends toward the doors in the middle.

Two of the 18 elevators each had a car leg grain blower that was powered by a motor of 5 horsepower, and had an hourly grain handling capacity of about 50 tons. The blowers were located on the first floor of the elevators near the door adjacent to the grain car spot on the railroad spur.

In Performing Custom Services

When custom services were offered by country elevators, additional facilities and equipment were usually required (fig. 13).

Grinder

In the elevators studied the feed grinder was usually of the hammer or burr type adjusted to grind whole grains. Grinders were equipped so that the grain being ground, primarily corn, oats, and barley, was forced into the grinder. The grinder usually was placed on the same base as its feed blower and motor. Combined they have a base of approximately 3 by 8 feet and were from 3 to 4 feet high. Strong air currents from a blower, conveyors, and chutes delivered the ground grain from the grinder to desired locations, such as to the legs, mixer, bagger, or motortrucks.

Grinders were usually in the basement of the structure, near the shellers, drags, and leg boots. Twelve elevators had one grinder each, 4 had 2, and 2 elevators had none. Their hourly capacities ranged from $2\frac{1}{2}$ to 15 tons and averaged about 11 tons. All were powered by electric motors ranging from 25 to 100 horsepower, and the average was 43. The grinder required more power than any other single piece of equipment in the elevator. One elevator used one grinder of large capacity and one small.

The volume of grinding to be done determined the grinding capacity needed. The size and capacity of the grinder; the kind of grain to be ground, whether large or small and damp or dry; the fineness desired; the manner of feeding grain into the grinder, whether under or over capacity--all were important factors in determining the amount of power needed. A grinder with a capacity of $2\frac{1}{2}$ tons per hour used a motor of no less than 35 horsepower, one of 4 tons used about 50 horsepower, and one of 6 tons used about 60 horsepower. One grinder with an hourly capacity of 12 tons was satisfactorily powered by an electric motor of 100 horsepower. In some elevators the underpowering of grinders prevented operation at full capacity.

Attrition Mill

The attrition mill is a type of grinder that pulverizes grain to a greater degree of fineness than the grinder normally used in custom-service operations. It grinds the higher fibered materials more effectively than does the grinder, the speed is higher, and the hourly capacity per unit of horsepower is usually less than the ordinary hammer or burr type grinder.

Four elevators had attrition mills. Two were in the basement and two on the first floor, each being powered with electric motors ranging from 15 to 40 horsepower. Mill capacity ranged from 3 to 6 tons per hour. Most of the mills had been in use for many years, and they were being used to supplement the grinders installed more recently.

Corn Cracker and Corn Cutter

Although the ultimate products from the corn cracker and the corn cutter were somewhat different in physical structure, the product from the corn cracker consisted of irregular sizes of the outer flint of the corn mixed with the more mealy portion of the kernel. The cutter tended to cut the corn grain in somewhat equal portions without a great deal of meal resulting. Neither the cutter nor the cracker was constructed as a grinder or an attrition mill and neither could function as such. The corn cutter was used for the clean cutting of the kernel to make scratch mixtures for poultry. Each type of equipment, with approximately the same hourly capacity and little difference in power requirements, was used mainly to reduce corn for further processing in either the attrition mill or the grain grinder, thus increasing the capacity of the mill and grinder. Corn cutter capacities ranged from 3 to 10 tons per hour and required from 7½ to 50 horsepower. They averaged 17 horsepower and a 5-ton hourly capacity. Two elevators used the cutter and cracker interchangeably.

Eight elevators had corn crackers, two of them also having a corn cutter in combination with the cracker. Two other elevators each had a corn cutter, and eight elevators had neither a cracker nor a cutter. Corn entered both the corn cracker and the corn cutter by gravity chute from above or was conveyed from the corn sheller or the grain dumps by drag. The cut or cracked corn moved from the cracker or cutter to the grinder, attrition mill, the mixer, or to the bagging chute, depending upon the end purpose of the product.

The smallest corn cracker, with an hourly production capacity of ½ ton, was powered by an electric motor of 7 horsepower, whereas the largest cracker with a capacity of 3 tons per hour was powered by a $7\frac{1}{2}$ horsepower electric motor.

Feed Mixer

The feed mixer and the feed grinder, attrition mill, corn cracker, and to some extent the corn cutter, complement one another. The feed mixers in use were of the hollow metal shell types in which were spiral or flat surfaces powered to rotate around a central axle. In the horizontal type the metal shell also rotated. The materials to be mixed entered at one end and, after being mixed, were emptied out at the other end. The lower portion of the vertical types were usually constructed in the form of a cone, through which the mixed materials passed. The mixture was removed from the mixer by gravity or mechanical power and was delivered to chutes for bagging or was conveyed in bulk to feed bins, wagons, or trailers.

In elevators that mixed and bagged their own labeled feeds, the mixers usually operated on a continuous flow principle with bagging at the outlet. In performing custom grinding and mixing for farmers, mixers operated on the batch-mix system, the requirements of the individual farmers being handled by batches.

In the elevators studied, a total of 36 feed mixers were found, only 1 of which was of the horizontal type. Three elevators had no mixers at all, and each of the remaining 15 had from 1 to 6. The number per elevator depended to a great extent upon the volume of mixing business done. The elevator with 6 mixers emphasized the manufacture of a bag-labeled line of commercial mixed feeds. Thirty mixers were on the first floor, usually called the work floor, and 6 were on the third floor. Mixer capacity ranged from $\frac{1}{2}$ to 5 tons, and the mixers were powered by electric motors ranging from 5 to 30 horsepower.

Hopper Scale and Utility Platform Scale

The hopper scale is one in which a large stationary hopper rests upon the scale beam, and quantities of grain in the hopper are weighed manually and then emptied by gravity from the hopper bottom into chutes leading to trucks or rail cars. The hopper, usually constructed of wood, had a capacity ranging from 30 to 200 bushels. Ordinarily, this scale was on the second-floor level of the elevator.

Of the 18 elevators 10 had hopper scales, and in 7 of the 10 the scales were used to supplement the automatic scales. Three elevators, however, had only hopper scales for weighing outgoing grain. Being manually operated, the grain-weighing capacity per hour was determined by the flow of grain into the hopper and the speed of recording weights and dumping, and averaged approximately 615 bushels per hour.

Utility platform scales usually were on the custom service work floor. Their sizes ranged from the small portable type having a maximum capacity of 300 pounds to the permanently installed type having a capacity up to 6,000 pounds. They were used to weigh bagged feeds, grains, seeds, and other materials in containers, and facilitated operation of the custom-service and merchandising operations.

Seed Sampler

Seed samplers were used by five elevators studied for analyzing samples of farm seeds. This piece of equipment required about 4 square feet of table space, was about 32 inches high, and was constructed mainly of brass or copper. The seed sampler was useful in two ways. It divided a large sample into small portions and separated, for examination, any foreign material of any type in the seed sample. It was used mainly for the inspection of small farm seeds at the time they were being purchased from farmers. Seed was placed in a top cone on the sampler and by gravity trickled into the many metal pockets at the base of the sampler.

Seed Cleaner

The seed cleaner is used to remove foreign materials from seeds and to clean clover, timothy, alfalfa, wheat, oats, and other small seeds. The elevators studied used it to clean seed for farmers as a custom service, as well as to clean seed purchased from farmers. Seed cleaners operating under several different principles of separation were found, but the principal types involved the use of moving screens, fans, and sifting devices. The seed cleaners discussed here include only those units specifically used to clean small grains and seeds; they do not include those cleaners or scalpers used in the grain-marketing operation of the elevator. The capacities of the seed cleaners ranged from 2½ bushels to several hundred bushels per hour, most cleaners having a capacity of from 4 to 25 bushels per hour. Small seed cleaners occupied as little as 8 square feet of floor space, whereas large cleaners required up to 80 square feet.

Fifteen elevators had a total of 30 seed cleaners. The other 3 elevators depended exclusively on scalpers for seed cleaning. Seed cleaners usually were located on the first floor of one of the elevator structures, often separate from the main work floor. They were powered by motors ranging from ½ to 5 horsepower.

Seed Treater

The seed treater is used for the treating of locally grown seed bought by the elevator for resale, and for service to farmers who grow and harvest seed for their own use and for market. It is used for applying chemical treatment to seed to destroy fungi, fungi spores, insects, and insect eggs. The seed treater usually was operated by a ½ horsepower electric motor and had a hopper into which the untreated seed was placed and from which the seed flowed into the mixing chamber, where the treatment was applied. The treated seed then flowed by gravity from the mixing chamber into a bag. Two elevators each had a treater for small farm seed as a part of the equipment located on the work floor. The hourly capacity of these treaters ranged from a few bushels up to several hundred bushels, the amount depending upon the size of the treater, the type of seed, and nature of treatment.

Bag Stitcher

The bag stitcher is essentially a portable type of sewing machine used to sew the open end of sacks filled with feed, seeds, and grains. The two elevators having stitchers were producing bagged feeds or seeds as side-line merchandising operations.

Grain Grader

A grain grader is a mechanism whereby an individual kind of grain can be separated from other kinds, and one size of grain or grain particle segregated from grains of other sizes, thus giving uniformity in kind, size, and quality of whole or broken grain. Only one elevator had a grain grader, and this was used to separate one kind of grain from another for farmers, as well as to obtain a uniform fineness in cracked grain for poultry scratches. This grain grader used a 1-horsepower motor and had a capacity of about 25 bushels per hour.

Other Equipment and Facilities

Previous sections of this chapter described those types of equipment primarily used in receiving and shipping grain and in the performance of custom-service operations. In addition, elevators had other equipment or facilities used at one time in handling grain for market, at another time in facilitating custom services for farmers, or sometimes used exclusively for carrying on side-line merchandising operations. The equipment and facilities discussed below are in this general category.

Grain Drier

Grain driers in the country elevators studied were used mostly for drying corn and to some extent for drying soybeans, but were seldom used for drying wheat, oats, or other grains. All driers operated on the constant-flow hot-air principle, but the mechanical methods of moving grain and applying heat varied widely in all driers (figs. 14, 15, and 16). The maximum temperature used was approximately 180° F. Five elevators had grain driers. Four of these were of the vertical type in which grain movement was by gravity, and one was the horizontal type in which grain movement was by power. The horizontal-type drier occupied a base

Figure 14.--Noninflammable masonry construction, built around a grain drier located adjacent to main elevator building.

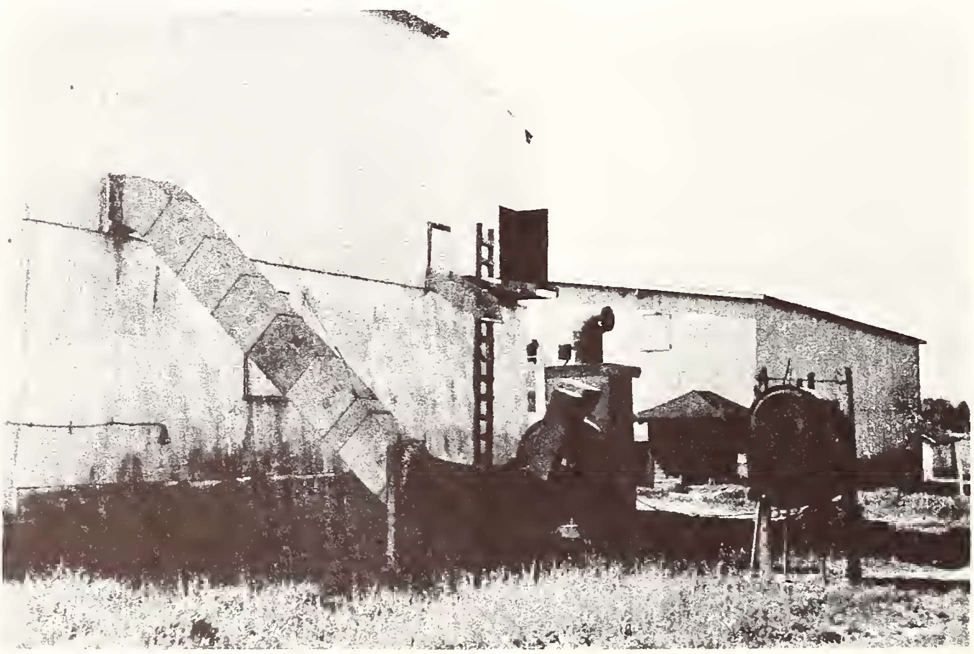

Figure 15.--Portable grain drier of small capacity used by some small elevators. This type of drier is used also on some farms that produce large amounts of grains.

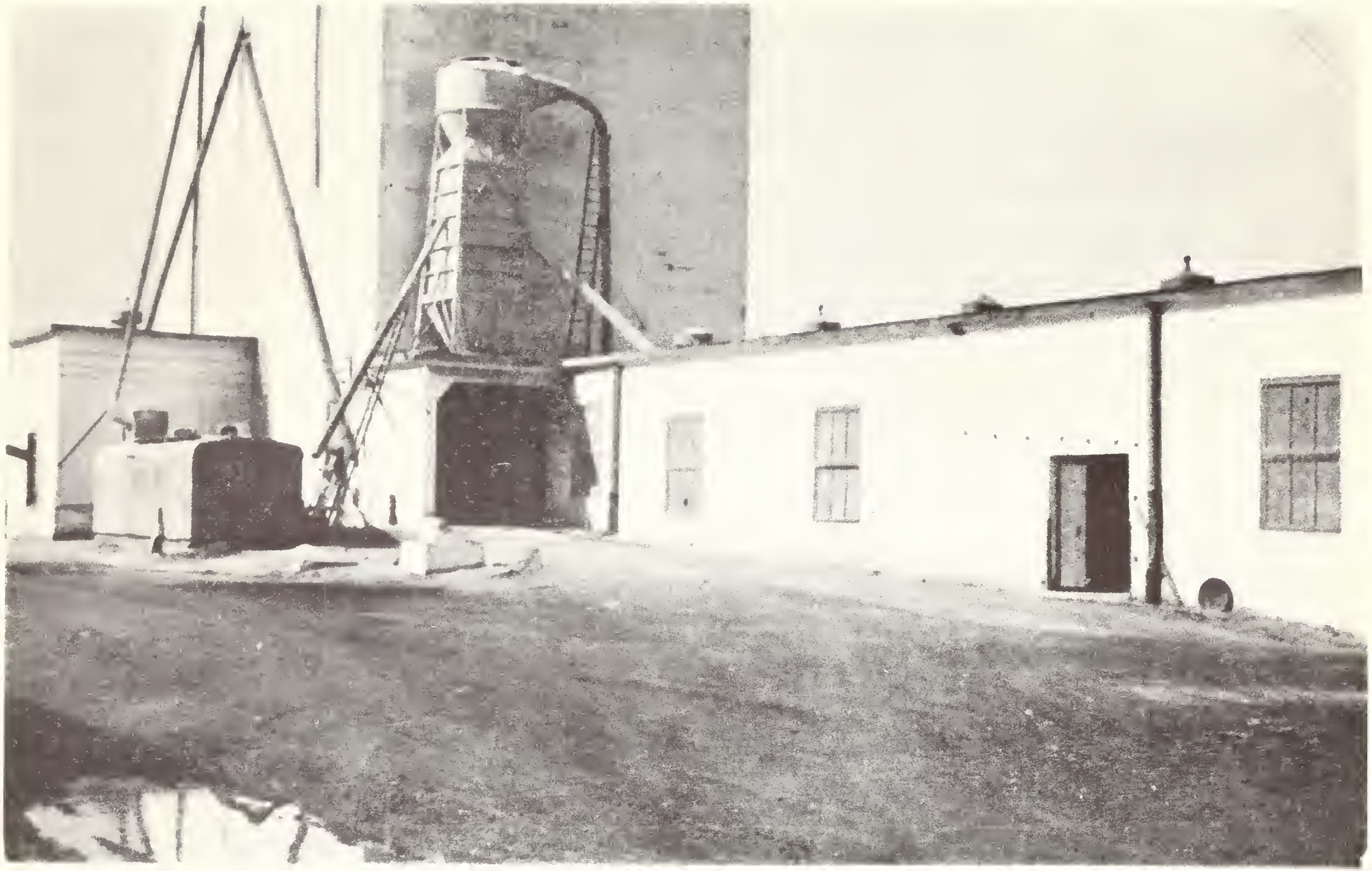

Figure 16.--A grain drier located outside the main structure decreases greatly the hazard of fire. This type of drier is fed by gravity from the main elevator structure, and the dried grain moves back into the main elevator by conveyor or drag. The grain drier is at the left. The dust collector is located over the driveway adjacent to the grinding and mixing room.

space approximately 10 by 40 feet and was about 8 feet high. The vertical-type driers occupied a space of about 16 by 16 feet and varied in height from 30 to 35 feet.

All types of driers were fed at the top by gravity chute, and the grain moved from the bottom of the driers either by conveyors or by gravity chutes into dump pits, boot pits, or other equipment. As pointed out previously, the hourly grain-drying capacities of the driers varied according to the volume of grain that could move through the drier and the amount of moisture reduction desired. Driers were operated at rates that varied from 80 to 800 bushels per hour. All heating units were fuel oil burners, and their consumption of oil per hour of operation was high. Exhaust fans, for both hot and cold air, required up to 10 horsepower. Driers were used for drying grain for farmers as a custom service and for drying grain purchased by the elevator.

Cob Crusher or Cutter

One elevator had a cob crusher, installed at the basement level, which was used to crush clean corncobs. This product was sold to farmers for poultry litter, cattle feed, bedding, and other uses. This cob crusher was powered by a 30-horsepower motor and had a capacity of about $1\frac{1}{2}$ tons per hour. Some other elevators studied had used their grain grinders at times for the grinding of cobs, but the heat generated made the operation unsatisfactory.

Grain Car Pullers

Of the 18 elevators included in the study, 5 had grain car pullers located either on the railroad platform or at the door of the main structure adjacent to the grain car spot. These motor-powered car pullers were constructed like a capstan, or a winch, using either steel cable or hemp rope to pull as many as five grain cars at a time. All car pullers likewise could be used to pull large scoops for unloading grain from cars into rail car grain dumps. In figure 17 the grain car puller is located on the platform above the rail car grain dump.

Elevator Power

During peak periods of grain marketing an elevator handling 800 bushels of grain per hour and operating a drier and car leg grain blower would use about 110 horsepower. An elevator operating at the same capacity but with grinding and mixing equipment as well as a drier would need about 200 horsepower.

Railroad Facilities

All elevators studied were on railroad spur tracks. Three elevators each had two spurs leading off from the main railroad tracks, two of which

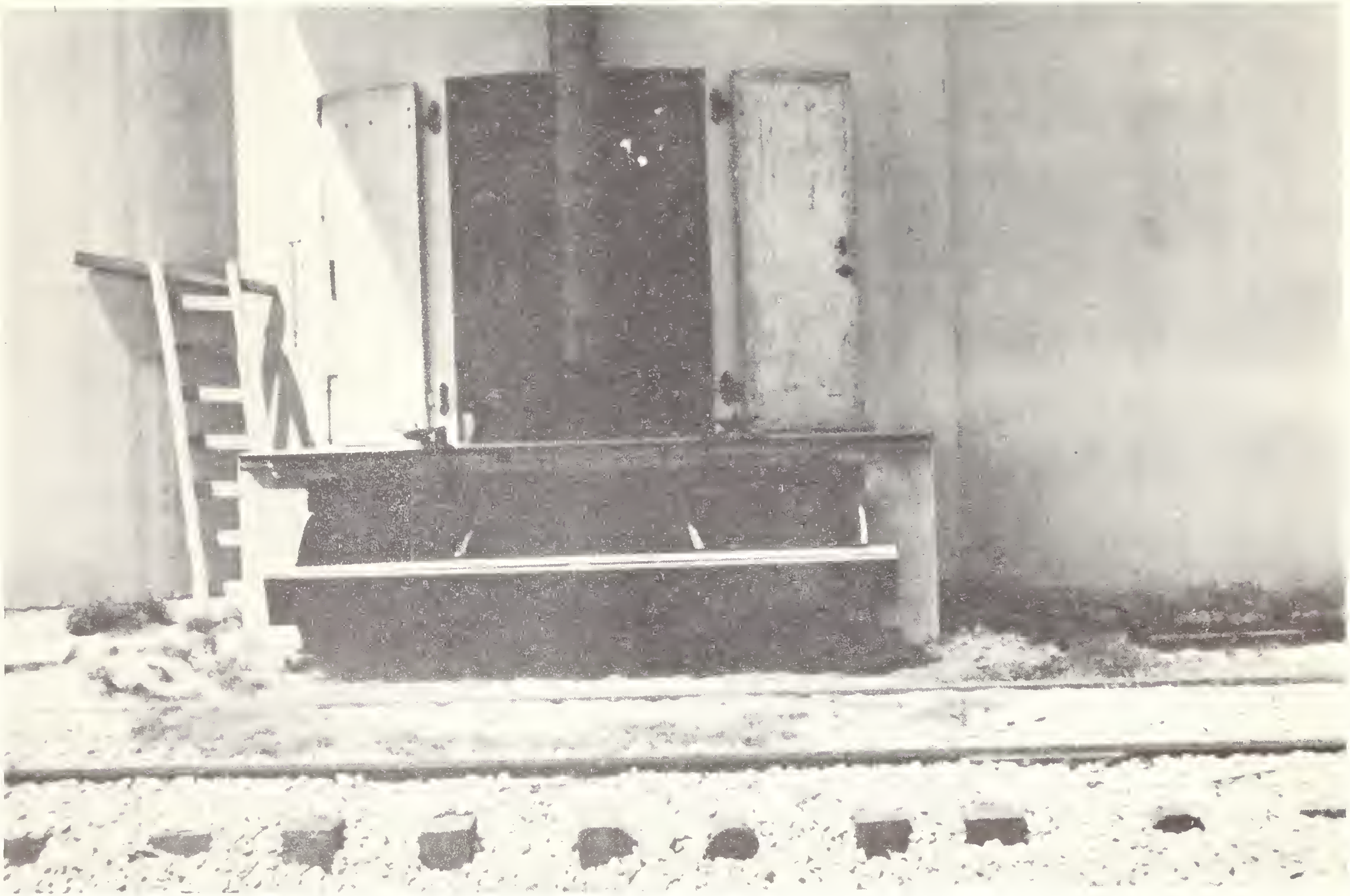

Figure 17.--A rail car grain dump, located along the spur track (underneath platform), into which grain flows from car door directly into dump pit at lower level. This device is good labor-saving equipment for elevators receiving bulk grain shipments by rail.

used both spurs for the loading of grain, but one of which used the second spur primarily for the unloading of coal.

The average spur capacity per elevator was 9 cars and ranged from 3 to 25 cars. Some elevators had trackage beyond elevator lot boundaries for holding reserve cars and the movement of cars when loaded.

Truck Facilities

All elevators owned and operated one or more trucks. They used trucks to deliver merchandise, such as coal, fertilizer, feed, fencing, and fence posts, to customers; to haul grain from farmers and for their own account; and to haul merchandise to the elevator.

Some elevators hired supplementary truck service, especially for hauling fertilizers, commercial feeds, and grains at peak harvest seasons.

The 18 elevators owned and operated a total of 45 motortrucks, the number ranging from 1 to 13 per elevator, and the average being $2\frac{1}{2}$ trucks. Most elevators had from 2 to 4 trucks, with capacities ranging from $\frac{1}{2}$ to 3 tons. Annual mileage ranged from 5,000 to 35,000 per truck, or an average of 26,000.

Storage Facilities for Side-line Merchandise

The amount of storage used for side-line merchandising was dependent upon the type and volume of such business carried on by the elevator. The handling of seeds, bagged feeds, and other miscellaneous farm supplies required supplemental structures to the main elevator building for storage and handling purposes. None of the main structures had sufficient room for carrying on this type of operation.

Ten elevators had feed and seed storage space in one-story buildings connected with the main elevator structure next to the railroad spur. Two of these buildings had platforms, about 30 by 16 feet and 48 inches high, next to the rail spur. The other 8 elevators had no platforms on the spur side, the merchandise being unloaded directly from car doors to storage floor.

Eight elevators had feed and seed storage structures about 100 feet from the tracks, and received nearly all of their incoming shipments by truck.

Structures used for feed and seed storage averaged about 45 feet long, 30 feet wide, and 14 feet high. In some elevators this space also was used as work-floor area in performing custom services. All except two of these buildings had platforms for the unloading and loading of trucks; the platforms averaged about 30 feet long, 10 feet wide, and from 39 to 51 inches high (figs. 18 and 19). At the two buildings without platforms,

Figure 18.--A platform at truck-bed height contributes to efficiency and lower labor cost. Loading and unloading can be done by the use of two- or four-wheel hand trucks.

Figure 19.--Roof attached to main elevator structure, sheltering trucks and truck platform, protects employees, customers, and merchandise while unloading and loading trucks.

trucks were unloaded or loaded at the doors. The storage of seeds as compared with bagged feeds required a relatively small space in all elevators except one, which had a highly specialized seed business. The need for storing seed came mainly in the winter months before seeding time, but bagged feeds required a large amount of storage space at all times. Elevators having separate storage space away from the workroom floor also used this floor area for storing feed ingredients for current use in custom services.

Coal was one of the major items of side-line merchandising, and was handled by all but one of the elevators. However, most elevators had no structures for its storage. About half of all the coal handled was unloaded from rail cars directly to trucks for immediate delivery. Seven elevators had coal bins bordering the spur tracks, some of them being covered. Two of the elevators had concrete bins, and five had wooden bins. Space in bins or on the ground (fig. 20) was sufficient to store several carloads at one time. The average space used for coal storage was approximately 120 feet by 30 feet, and the bins averaged 28 feet by 20 feet by 17 feet in height.

The sale of farm machinery was a major side-line enterprise for three elevators, each of which had separate structures for storing these items. One elevator unloaded machinery from rail cars onto the ground, whereas the other two unloaded onto platforms at car-floor height. The special structures for storing farm machinery, one of which was made of brick and two of wood and metal, averaged about 100 feet long and 38 feet wide. The overflow stock was placed in open areas on the lot. These buildings included space for shop and repair work.

Most fencing was stored in the open. In a few instances some stock was scattered here and there under shelter or on an open platform, wherever space permitted, and usually such items as fence posts, bridge lumber, galvanized waterers and feeders, brooder houses, and other bulky items were stored with it.

Manlifts, Ladders, and Stairways

Some of the early country elevators had only a ladder as a means of contact between floors. Others had a narrow stairway and a ladder. Recently constructed elevators, reflecting the safety factor, had a wider stairway and the manlift (a manually operated passenger elevator). On the early constructed manlifts, many of which are in use today, the balance weight was approximately the same as the weight of the passenger, who pulled himself up by the hand-over-hand method and descended by gravity (fig. 21). The electric-powered manlift, with pushbutton controls, has replaced many of the older installations and at the time of the study had been installed in most of the recently constructed elevators.

The 18 elevators had a total of 27 manlifts. Only 5 were motor-powered and were in elevators of more recent construction. Two of the

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Figure 20.--Most country elevators do without special coal storage facilities, but a few have elaborate and costly structures.

Figure 21.--Elevator legs of wooden construction are spaced to permit placement of manlift between them.

electric lifts were of the two-passenger type, and one was of the endless-belt type. The belt was about 20 inches wide, and attached to it at regular intervals were rigid metal platforms, upon which the passenger stood.

Sixteen units had a total of 19 stairways, and four units depended upon the combined use of manlift and ladder, the ladder being used only in case of emergency. Two stairways were of the spiral-type metal construction; the remainder were of wood, with open tread and mostly of one-man width. One elevator had one stairway inside and another outside, the latter built for use in case of fire.

Coal Toter and Conveyor

The coal toter (fig. 22) is a powered portable horizontal conveyor used for the conveyance of coal from beneath the coal cars. It is also used in the handling of other materials such as limestone and crushed rock. It is constructed for operation under the gondola-type railway car, and it mechanically delivers the material being handled to the base of the coal conveyor or dumps it on the ground beside the tracks. Nine of the elevators used toters, which ranged in capacity from 15 to 50 tons per hour. All were powered by electric motors, except one which was powered by a gasoline engine. Motors ranged from 3 to 5 horsepower each, the 5-horsepower motors predominating.

The coal conveyor (fig. 22) is a powered mechanism by which coal or other material is conveyed and elevated to a higher level. A hopper is located at one end of the conveyor, into which the coal or other material is placed by the coal toter or by hand labor. The moving endless chain conveys the coal or other material to a higher elevation, carrying it a distance of about 25 feet and emptying it into trucks, bins, or coal piles.

Fourteen of the 18 elevators had a total of 15 coal conveyors. Hourly handling capacity ranged from 25 to 50 tons, the amount depending upon the size of the conveyor, the power used, and the size and grade of the coal. Most of the conveyors had an hourly capacity of from 40 to 50 tons. Motor power was relatively low, averaging 4.3 horsepower on the 15 conveyors.

Miscellaneous Equipment

In some of the 18 elevators, at least one and often more than one of the following pieces of equipment were found in use: Bag cleaner, vertical bag conveyor, bag chutes, four-wheel hand carts, feed carts, huller and scarifier, grain bin thermometer, dust masks, special types of fire extinguishers, and lightning arresters.

Figure 22.--The coal toter and the coal conveyor make a labor-saving team.

MANAGEMENT AND SOME OPERATING PRACTICES

Management and Labor

The managers of the 18 elevators had an average of 12 years experience in the elevator business, about half of which was on their current jobs. Thirteen managers had worked in country elevators before assuming their present position, two had farmed, one had done sales work, and two came to their current jobs from the armed forces.

The number of employees other than managers ranged from 2 to 24, the average per elevator being 7; most of them were employed the year-round. Eleven elevators used extra seasonal labor, mostly for handling grain during the peak of harvest, but to a small extent for handling coal. Employees were mainly laborers, truck drivers, salesmen, and accountants. The volume and type of business done and the number of side-line enterprises determined to a great extent the number of persons employed.

Twelve elevators usually gave employees (other than the manager) a bonus at the end of the calendar year, and the employees of all elevators received overtime pay for work in excess of 40 hours.

Keeping labor busy in productive activities was one of the many responsibilities of the manager, and was a substantial factor in the financial success of the elevators studied. Units with many side-line activities, such as the handling of coal, lumber, and feed, and performing custom services had greater possibilities for keeping labor busy than did those elevators that limited their activities mainly to the handling of grain. For example, one elevator with a side line of lumber and building supplies employed yard labor with appreciable carpentry skill. A small shop supplemented the lumber yard, and the yard laborers always had remunerative projects standing by for rainy days. They built individual hog houses, brooder houses, or some other type of portable equipment for farm use.

Alert and intelligent management was obvious in some elevators. Proof lay in operational records and net incomes. Good management apparently centered around the idea that the elevator's success depended upon rendering service to the community. The manager's ability to go out into this area and sell the services of his elevator to farmers and other local people, and then operate his elevator in a manner whereby his customers were pleased and returned to do more business, seemed a prime requisite of management. In the area studied any farmer had access to several country elevators, so the elevator manager who rendered the best service in the most amiable way seemed gradually to acquire the greatest proportion of the territory business. With about two-thirds of all country elevator income being derived from the sale of side-line merchandise the necessity for a manager to be a good salesman was apparent. This salesmanship extended into giving sound advice and suggestions regarding grain feeds and feed mixes most desirable in feeding various kinds of livestock, as well as a thorough knowledge of the value and use of farm equipment, some of which the elevator had for sale.

The good elevator manager apparently had a thorough knowledge of the mechanical operation of his elevator, so that equipment and machinery could be maintained and operated at the maximum efficiency without too many breakdowns and too much depreciation. He kept abreast of current new ways and methods of doing things. Apparently, a good manager was never satisfied with the operation of the mechanical equipment in his elevator. He knew specifically a number of things which were wrong with it and had plans for their improvement.

Not all of the managers of the elevators studied had all of the above attributes or knowledge. The degree ran from average to high. The most serious defect was the apparent lack of appreciation of the fact that business does not automatically get to an elevator because it happens to be the only one within a few miles. It was good salesmanship and efficient operation that attracted business to the elevator.

Prevention of Loss and Injury

Records of loss and injuries to helpers, facilities, and equipment in old elevators as well as in those constructed within the past 10 years indicated inadequate facilities and equipment for the prevention of injuries to personnel and of loss of equipment and facilities from breakage and fire. The operation of a country elevator in itself is a hazardous occupation because of its considerable height, covering several floors, upon which rapidly moving machinery is operated. When these hazards are combined with inadequate or faulty devices and careless personnel, injuries to personnel and damage to equipment and facilities result. Experience in the elevators studied indicate that in too many cases the need for the prevention of such injuries and losses became apparent only after an elevator had burned or someone was permanently injured.

Fire was one of the outstanding hazards, particularly in facilities constructed of wood. Fires were caused mainly by: (1) Faulty and inadequate electrical connections and controls; (2) sparks from machinery, foreign metal in machinery, and friction of belts on wood; (3) accumulation of dust, trash, husks, oil, and other inflammable debris; (4) careless personnel; and (5) lightning. An accumulation of dust offered an excellent medium for sparks, starting slow moving smouldering fires that ignited when they reached more readily inflammable debris and wood. The draft in an elevator was nearly always upward, and as personnel was usually occupied at the lower levels, many fires got out of hand before discovered, and even broke out when the elevator was not being operated. With the exception of fire by lightning, the risk of which could be greatly minimized by adequate grounding, practically all elevator fires had been caused by careless management in neglecting to correct obvious defects or the carelessness of labor and others in the elevator structure. (See figs. 23, 24, and 25.)

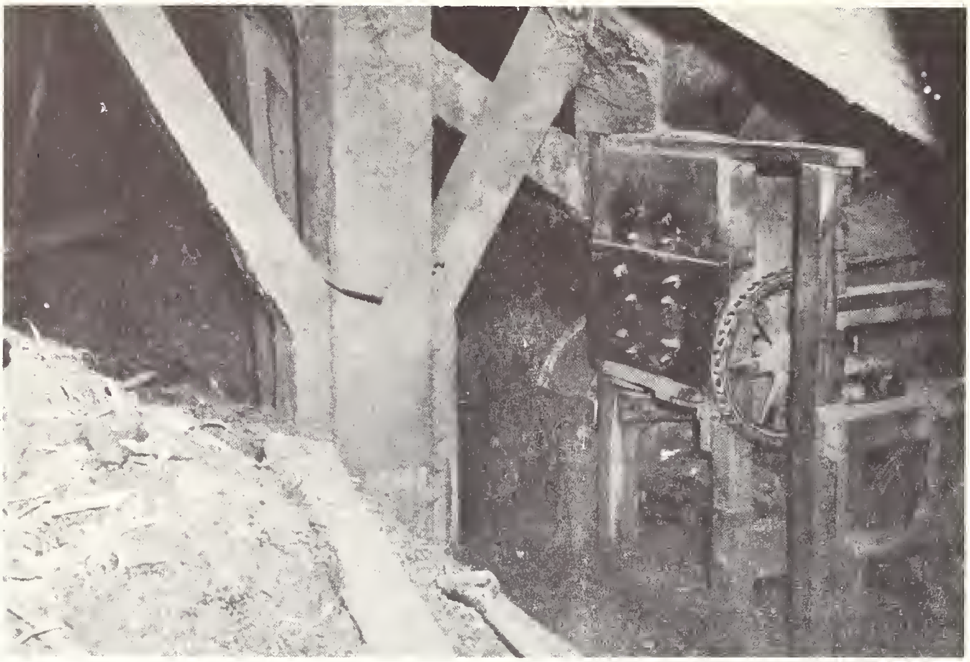

Figure 23.--Good management does not permit the accumulation of trash, spoiled grain, corn husks, dust, and other materials as shown above.

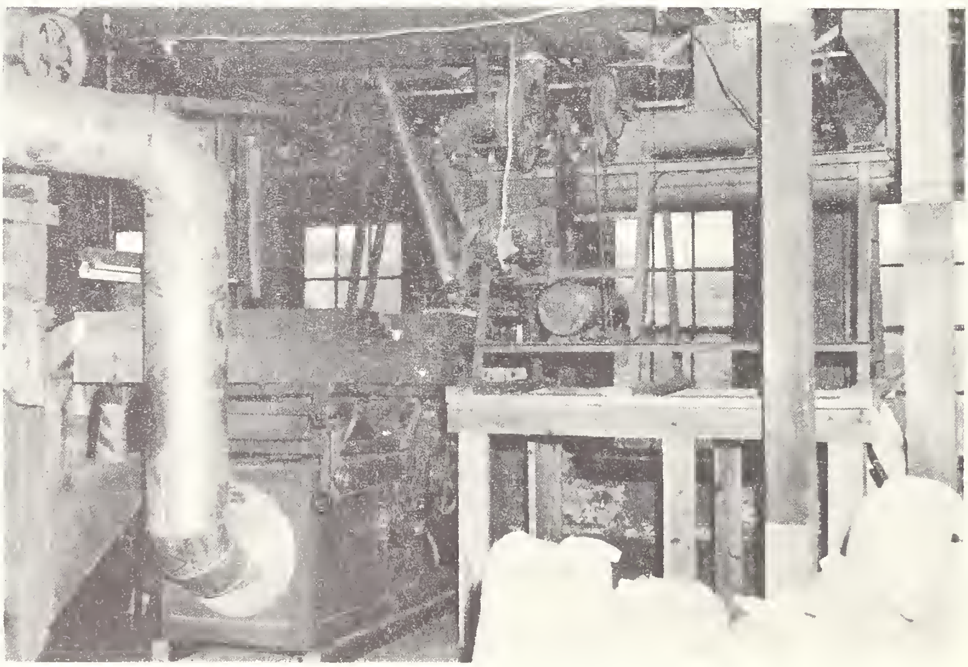

Figure 24.--Good housekeeping is a part of efficient management; it contributes to prevention of losses and injury.

Figure 25.--Accumulation of elevator dust increases fire hazards and increases costs of operation. Here, the dust on the floor was approximately a foot deep, and the belt ran through a pile of dust which had accumulated adjacent to the motor. Any friction or electric spark is an excellent medium for expanding into a major fire. This fire hazard was located on the second floor of the elevator where visits by personnel were not frequent.

Accidents to personnel were caused mainly by: (1) Lack of mechanical safeguards on moving machinery; (2) lack of guard rails and fences around manlift openings, stair wells, stairways, and ladderways (fig. 26); (3) placement of machinery in such a way as to interfere with the free movement of personnel in operation and repairs; (4) lack of emergency controls on machinery; (5) lack of good housekeeping including cleanliness, and systematic storage of tools, equipment, and supplies; and (6) carelessness of personnel. Even with the best accident prevention equipment, it is quite easy for careless and unthinking personnel to be seriously injured in an elevator. In some elevators the installation of adequate safeguards and a thorough training of personnel as to the hazards in the operation of the equipment and moving from one place to another in the elevator had demonstrated its value in the prevention of accidents.

Grain Losses

The country elevator manager sells grain on the basis of grade, determined by several factors, such as cubic weight, dockage, moisture content, etc. Consequently, in the elevators studied he adjusted grain buying practices to sales grade requirements. For example, 60 pounds of grain having an 18 percent moisture content, other conditions being equal, would not be worth as much as 60 pounds of grain of 14 percent moisture. Likewise, a cubic bushel of sound grain carrying considerable foreign material, such as straw, weed seeds, chaff, etc., weighed less than the standard bushel weight. Also, the grain may have been mixed with heavy weed seed and weighed more than the standard cubic bushel. A load of ear corn might include a heavy percentage by weight of corn husks which were weighed as a part of the purchase. Some ear corn had large cobs with ears only partially filled, with shallow and immature kernels, thus resulting in much less merchantable shelled corn as well as a lower grade. These and other factors were all considered by the elevator manager in purchasing grain, and the experienced manager made allowances in his purchase price to cover factors affecting market values. However, even with the best equipment at hand for determining grain moisture content, dockage, weight by volume, etc., and with the best experience and judgment, not all chances of errors were eliminated.

Grain losses occur in weight as well as in quality. Some of the causes of loss in weight are: (1) Leakage, (2) elevator plug-ups, (3) hidden storage losses, (4) insects, (5) rodents, (6) errors in weighing, and (7) improper adjustment of elevator equipment. Quality losses, with a resultant loss in grade, are caused by: (1) Fungi, (2) inadequate cleaning, (3) excess moisture, (4) operational errors in mixing grains of different quality, (5) shelling out (corn), and (6) managerial errors in the judging and reading of test samples.

One of the heaviest losses in weight came from improper equipment, improper adjustment, and overloading the scalper beyond its most efficient working speed and capacity. Estimates of loss from leakage ranged from none to 1 percent, and more than half of the managers of the elevators

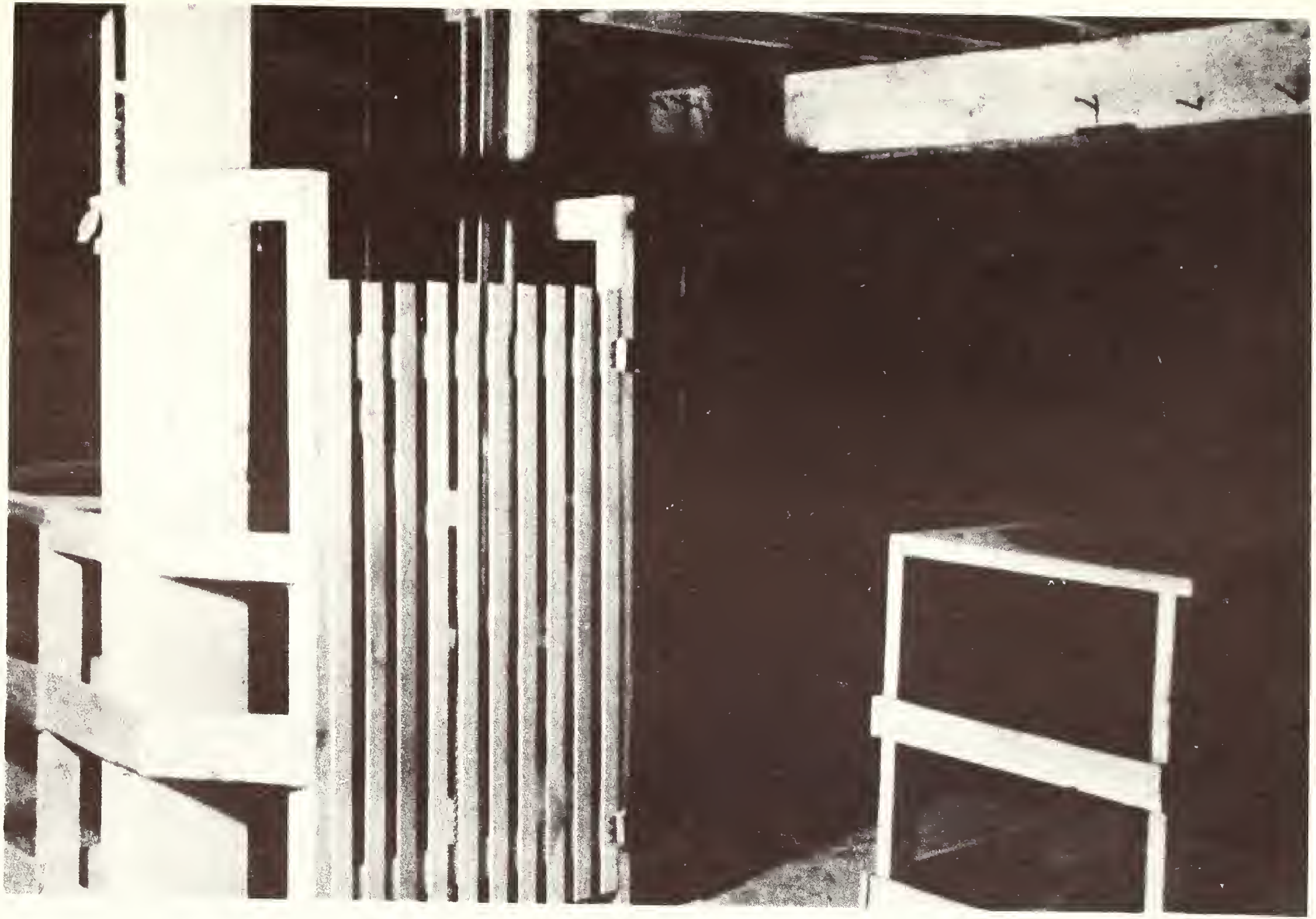

Figure 26.--Safety gates and guard rails for manlift shafts and stairway wells contribute to safety at small cost.

studied estimated that they had little or no leakage losses. Difficulty was experienced in arriving at loss estimates caused by elevator plug-ups and long time storage, although both were recognized as significant. Estimates of shrinkage in weight due to insects ranged from none to $\frac{1}{4}$ of 1 percent. More than half of the managers considered this factor as inconsequential. Most managers reported no appreciable loss from rodents, but nearly half the operators said that this loss ranged from 1/10 to $\frac{1}{4}$ of 1 percent. Mathematical errors in weighing are always subject to correction, but when a scale ticket, upon which weights were recorded, was lost, the elevator usually took the loss, since attempts to arrive at an estimated weight were most often favorable to the customer.

Nine units followed the policy of depending mainly upon turning the grain for protection against insect pests, 7 used gas, and 2 depended upon grain drier equipment. Grain, in the area studied, was not subject to serious weevil or other insect infestation as is grain produced and stored in warmer climates. Fumigation costs, where such measures were necessary, were estimated to be from $\frac{1}{4}$ to 3 cents per bushel, while that on turning and cleaning ranged from $\frac{1}{4}$ to 2 cents per bushel. Little or no losses from rodents occurred when precautionary measures such as the use of hardware cloth, metal, and concrete were used in the areas where grain otherwise would be exposed.

Overages in the weight of grain also occurred, although less frequently than losses. Examples of conditions which resulted in weight overage were: (1) Increase in moisture content; (2) shelling out, particularly on ear corn of high quality; and (3) errors at time of purchase and weighing.

Overages in quality were sometimes brought about after purchase by skillful blending of grains of the best quality with those of lower quality to improve average grade of all lots blended, reduction in moisture, and cleaning to eliminate foreign material.

Sales and Purchase Practices

Certain terms are used by those who buy and sell grain. For example, grain is sold "on track" when it passes from seller to buyer at a definitely agreed upon price, based on a specific quantity and grade, at the time of acceptance by the railroad or other common carrier. The term "consigned" is applied to a shipment which the owner delivers to his agent for sale, with or without restrictions as to price, the agent usually being located in a distant market. In the sale of grain for future delivery, the owner contracts to deliver a specific quantity and grade at a definite future date or within certain specified dates at a specific price.

Almost all grain purchased by elevators from farmers was for cash. Nearly all grain sold was "on track," on a day-to-day cash basis. The grain remained at the elevator such a short time that very little hedging was done or needed as insurance against price changes. Under these conditions serious consequences occasionally resulted from grain car shortages. Grain received at elevators operating under some form of group control, such as line or cooperative, was covered by hedging operations at the central office, but such operations were not a part of the sales procedures at country line elevators. The entire sales policy was predicated upon the rapid movement of the grain away from the elevator, with a minimum holding period of the grain in storage at the elevator.

All sales of side-line merchandise were for cash at the time of sale or within 30 days. Discounts on certain highly competitive merchandising items, such as fertilizers and feeds, were given by some managers.

The mark-up on side-line items varied appreciably among elevators. The approximate average mark-up on coal by the 17 elevators which handled it was 18 percent. The 16 elevators handling commercial and ingredient feeds added an average of about 15 percent. On fertilizer, the 13 elevators added an average of approximately 9.6 percent, and the 16 elevators which handled small farm seeds marked up those items by an average of about 17 percent, with 9 percent on seed grain, and 5.4 percent on feed grains. The average mark-up on fence was about 15 percent, and numerous miscellaneous items ranged from 17 to 30 percent. All elevators took full advantage of available discounts on side-line items purchased for resale. Approximately 85 percent of the volume of all merchandise and grain purchased and sold was on a cash basis. Orders for seasonal items, such as farm seeds and fertilizer, were usually placed in advance and paid for on delivery.

INCOME, EXPENSE, AND INVESTMENT

In an attempt to determine what made a country elevator a financial success special attention was given to the factors which caused failure. Several managers stated that a country elevator situated in a suitable location and operated on a sound basis during the decade preceding the time of this study could not help but make a profit. However, data collected in the study showed that several elevators lost money on some kinds of grain during the 3-year period 1947-49. Almost without exception these losses occurred when the elevator became a tool for speculation in grain. Usually, these losses were associated with the units of higher capacity, above 50,000 bushels. In almost all instances where losses occurred, they were connected with the holding of grain by elevator operators on their own account over a period of several months past harvest season. Fortunately, those elevators which experienced substantial losses on stored elevator-owned grain had sufficient reserves to continue in business or their losses were offset by profits on other operations. Grain speculation losses or gains were eliminated from the income and expense data shown in table 5 as not being a true reflection of sound elevator operation.

Income

From Marketing Grain

Farmers marketed more corn than any other grain, and soybeans were next in importance, these two grains being the bulk of the movement through the elevators. This was true for all elevators in the study. The volume moved had little relation to the storage capacity of the elevator, the average elevator in the second group handling more grain than that in the fourth group. The average gross margin 4/ of all elevators in grain-handling operations was $15,000, with the margins of the first four groups not significantly different. The average gross margin per bushel of all grain marketed was about 5½ cents, with no group of elevators varying more than 1 cent either way from this amount. The average elevator in the group having the largest storage capacity handled about twice as much grain as the average of those in all other groups but had a gross margin per bushel about the same as the other groups. Records of individual elevators indicated that some small elevators handled as much grain as some large elevators, apparently needing only a small amount of storage space in the movement.

The gross income from grain handling was 23 percent of the total gross income from all sources, ranging from about 17 percent in the larger elevators to about 30 percent in the smaller elevators. The income of the larger elevators from certain highly specialized side-line enterprises was quite high.

4/. Difference between purchase and sales price.

Table 5.--Average income and expenses per elevator, by size group, 1947-49, 1/

Elevators in group 2/	Gross income from--									Expenses			Net profit (before Federal income tax)
	Grain handling						Custom services	Merchandise sales	Total gross income	Management and labor	Overhead and miscellaneous	Total expenses	
	Total volume of all grains handled	Corn	Wheat	Oats	Soybeans	Total							
	Bushels	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
4	198,500	6,000	2,000	700	3,200	11,900	5,700	19,900	37,500	13,500	11,700	25,200	12,200
5	239,500	5,000	1,800	1,000	2,800	10,600	6,000	22,100	38,700	15,700	15,200	30,900	7.800
3	240,500	6,500	1,600	1,300	5,100	14,500	8,100	31,500	54,100	19,300	14,600	33,900	20,200
3	225,000	7,200	800	700	2,900	11,600	11,300	13,600	36,500	12,400	12,500	24,900	11,600
3	454,000	14,700	3,200	1,700	6,600	26,200	4,900	124,800	155,900	54,500	42,100	96,600	59,300

1/ Figures rounded.
2/ By rated storage capacity as shown in table 1, page 1.

From Performing Custom Services

Income from custom services, mainly shelling, grinding, grinding and mixing, cleaning, storage, weighing, grading, drying, hauling, and the servicing of farm machinery averaged $7,200 per elevator, and was 11 percent of the gross income of all elevators. In a majority of the elevators custom service income tended to be somewhat more than half as much as the income from buying and shipping grain. However, some elevators, especially those in the fourth group, had developed this business to the point where the income from custom services nearly equaled that of marketing grain. The managers of these elevators usually expected the income from this source to meet their current pay-rolls. The group of largest elevators, which marketed the greatest volume of grain, had a comparatively small income from custom services primarily because of their location within larger towns and the lack of emphasis placed on side-line merchandising.

From Selling Side-line Merchandise

Gross income from side-line merchandising made up about two-thirds of all income to the average elevator studied. In only one group of elevators was the income from this source less than the combined income from grain marketing and performing custom services. In this group emphasis was put on custom services, the income from which was relatively high. In the group of largest elevators about 80 percent of all income was from side-line merchandising. These elevators had expanded this business to the point where grain receiving was a minor function although they had been built solely for this purpose many years ago.

The three most important merchandising items handled by a majority of the elevators were coal, bagged feeds and feed ingredients, and seeds, and in 14 elevators these three items constituted major enterprises. Through years of experience, essentially by trial and error methods, some elevators had taken advantage of local opportunities in merchandising such items as fertilizer, farm machinery, lumber and building supplies, brick, tile, poultry supplies and equipment, hardware, farm tools, machinery parts, electrical supplies, used farm machinery, paints, petroleum products and tires, insect sprays and equipment, hog houses and feeders, fencing, and many other items which were in demand in local areas.

Expense

Management and labor cost made up about 55 percent of all expenses in carrying on the business of the average elevator. Bookkeeping methods used by the elevators did not allow any reasonable allocation of these expenses to the individual operations of handling grain, performing custom services, and merchandising side-line items. Data in table 5 indicate that, for the elevators studied, expenses for management and labor approximated very little more than one-third of the total gross income. Any substantial upward departure from this proportion was reflected in lowered net incomes.

Overhead and miscellaneous expenses, which include all expenses of operation except management and labor costs, tend to be about 45 percent of all expenses. Those elevators in which overhead and miscellaneous expenses were less than the cost of management and labor had the largest net incomes. Because the various side lines demanded labor and facilities to varying degrees, no consistent similarities or common relationships other than the generalities indicated in the table would be valid. For the average of the three years all elevators showed a profit, from the smallest to the largest. Although the two groups of smaller elevators had about the same gross income, the net profit of the smallest group was more than $1\frac{1}{2}$ times that in the other group.

Capital Investment

The values of land, buildings, and equipment of the elevators studied ranged from $22,550 to $90,485, with an average of approximately $38,000. These values were those carried on the books for accounting purposes, and might or might not be a reflection of either the market or replacement values. Generally, elevators tended to have a market value based on their ability to make profits in their combined operations. Information on the original investment made by the current owners was not available, but it was apparent that such purchases were made on the basis of value other than the values of the physical plant and storage capacity of the elevator.

The total current assets of the elevators varied widely, but in general they tended to be two to three times the combined value of land, buildings, and equipment. Average inventory values for the 3-year period were approximately $43,000. Apparently side-line merchandising to the extent done by elevators in this study involved the use of much more capital than needed for the investment in land, buildings, and equipment.

DEFECTS IN ELEVATORS STUDIED

Detailed comparisons of operations, facilities, and equipment led to some rather obvious conclusions regarding the relative inefficiencies of the elevators studied and their causes. The managers were aware of some of these shortcomings, with which they contended daily, and freely offered opinions and facts regarding them.

Trade Area Too Small for Grain-Marketing Operation Only

An analysis of the average volume of grain handled per elevator indicates that the trade area surrounding most of the individual elevators was too small to yield a sufficient volume of surplus grain to support the elevator from this operation alone. Very few, if any, of the elevators studied could have survived as business enterprises upon the revenue which was derived from grain marketing alone, and even with that revenue from custom services many would have been liquidated. The volume of grain received and shipped by the average elevator kept it in operation only about 50 days annually. For the years included in this study the revenue from this source was only 23 percent of the total income, while the revenue from custom services was only 11 percent. Any one elevator studied, with possibly one exception, could have handled two to three times the volume of grain that it did handle and still have had time to do custom services. It is realized that marketing of the grain has a distinct seasonal pattern, but in the areas studied the movement of corn from farms to elevators is spread over a period of several months. With the relatively small volume of grain-marketing business to be done, the necessity and desirability of engaging in side-line merchandising was quite apparent.

Location in Congested Areas

The location within the trade areas was chosen 20, 30, and even 60 years before this study. The prime factor then was the availability of rail transportation, but a secondary consideration seems to have been a desire to locate near the center of town. In some instances, however, the town had grown up around the elevator.

The availability of rail transportation continues to be important. But conditions which have arisen during the past half century have made these locations undesirable in other respects, sometimes resulting in high operational costs. For instance, some elevators were located in cities and towns with tax rates 75 to 100 percent higher than those of rural areas.

A primary defect observed in the existing locations was that there was no practical way of expanding the land area in the sites. Unfortunately, most of the sites were surrounded by business and residential properties of such value as to make expansion financially prohibitive.

The lots were small, driveways were often inadequate for handling normal service, and space was lacking for new structures. This defect was intensified by the fact that the construction of the principal structure (frequently the only one of much value) was such that it could not be used advantageously by any other type of industry. After permanent structures were placed on a site, it was too late to correct faulty site selection.

Another disadvantage of a location near the center of town was that even with modern equipment for the control of dust, the area for a considerable distance surrounding the elevator was dusty. Quite naturally, the townspeople disliked the inconvenience of dusty homes and the discomfort of the dusty atmosphere.

The inefficient burning of dust and cobs within the city limits created a smoke nuisance, causing many city governments to establish regulations, which increased cost of operation. Elevators located in towns and cities where such regulations were in effect spent as much as $2,500 annually for the disposal of dust and cobs. Many operators were required to truck these wastes to rural areas, where they were burned or given away. Country elevator operators were finding it increasingly profitable to feed suitable wastes to livestock, but for those elevators located within the city or town limits this source of side-line revenue was limited.

Six of the sites were sufficiently separated from business and residential districts so that there was no interference between elevator operations and community interests. However, 15 sites were located within city limits, and costs of operation were adversely affected by city tax rates.

Various defects were seen in the selection of sites, of which a common one was that of sites that were too small and especially too narrow. The location of one site which bordered a main railroad line endangered the lives of those who entered or left the site. No warning signals had been installed, and vision of the main line was poor. Another site was divided by a main highway, thus creating delay and endangering lives of customers and employees in getting to and from the detached area. A third site was located on a busy city street near the center of the city, with elevator buildings covering the entire lot. In recognition of the unfortunate location of this elevator the management had adjusted operating and servicing policies and had practically eliminated custom services in order to make best use of existing facilities. There was no room for expansion of this elevator operation on the existing site.

<u>Poor Layout of Structures on Sites</u>

At many of the elevators the lack of space adjacent to the railroad spur prevented the location of additional storage facilities for grain as well as for feed, farm implements, seed, and other side-line items along the track. Thus new structures were located away from the spur. These locations had appreciably increased the handling costs, and unfortunately the most efficient handling equipment was not being used in most elevators. In the case of one elevator which gave special emphasis to the handling of farm seeds, the seed storage structure was not adjacent to a railroad spur, and all seed received by rail was rehandled. Half of the units handling lumber had no railroad spur servicing the lumber storage yard. All rail receipts were loaded onto trucks and rehandled in the yard. A few elevators found it necessary to unload coal into trucks and deliver it to off-rail storage areas due to lack of space adjacent to railroad spurs.

In approximately 50 percent of the elevators which ground, mixed, and sold feeds, the work floor was at some distance from the main feed storage room, often as much as 100 feet. In such instances bagged feed was either moved to the work floor and through it, or labor had to leave the work floor and go to the feed storage room to deliver merchandise to customers.

More than 40 percent of the elevators had seed storage space that was poorly located. In some units one kind of seed was stored with feed, and another kind was placed in the office where the seed bags were used in lieu of chairs for waiting customers. When it was necessary to obtain merchandise from several areas to fill one seed order, time was lost.

Inadequate Structures and Equipment

Nearly all of the main elevator structures included in this study were of wood, which were highly subject to destruction by fire. In the main structure as well as in supplementary buildings used for feed, seed, and other supplies space was often inadequate, and items of merchandise which should have been segregated were piled together, resulting in injury to the merchandise and increased cost of handling. Many managers stated that the average country elevator does not have enough of the proper kind of storage facilities to meet its needs.

Although many improvements have been made, many defects remained to be corrected which concerned the safety of employees and facilities. In some instances simple improvements could have been made at little cost, such as the installation of guard rails on stairways, gates and guard fences on all floors around the manlift, and the use of nonfreeze solutions and fire extinguishers at all levels. Many defects existed in grain pit protection, electric wiring and equipment, power and speed adjustments, lightning rods, and failure to carry out rigid regulations against smoking in danger areas. Driveways to grain pits in several units were as narrow as 10 feet when they should have been not less than 12 feet. Cob storage over driveways in the main facility of several elevators littered up the driveway and used valuable space. Almost half of the units were deficient in platform space, particularly for the servicing of trucks.

Some elevators were without private office facilities, a convenience greatly appreciated by customers and especially advantageous to management. Others had inadequate office space, and relatively few had display windows. Most offices were too close to the main structure to permit over-all facility observation. Over half of the offices were without adequate waiting room space and toilet facilities for employees and customers, and about the same number of offices were much too crowded with farm supplies because of inadequate floor space.

Those elevators handling grain and coal had need for much less equipment than those which did grinding and mixing and handled stock feeds and other farm supplies. Of the former, the absence of grain-drying equipment was a handicap to maximum income and proper customer service. Some grain driers were of too low hourly capacity for the most effective use in seasons when large quantities of high moisture grain were received.

Several elevators were in need of improved equipment for cleaning and also needed additional equipment, such as distributors, larger truck scales, scalpers, recleaners, conveyors, magnetic separators, manlifts, and dust collectors. Three elevators could have profitably used additional mechanized equipment for unloading, loading, and stacking of feeds and seeds. Several elevator units could have used cob blowers, coal toters, car-leg grain blowers, and a higher speed leg to advantage. Most units should have taken increased advantage of chutes and portable and stationary conveyors (fig. 27). Five units needed greater rail spur capacity and five were deficient in grain pit capacity. Several units doing grinding and mixing could well have given consideration to the addition of an extra grinder. Approximately 20 percent of the elevator legs were 50 percent or more deficient in carrying capacity, and most elevators were in need of transfer legs for increased flexibility. About 30 percent of the elevators were defective in drag capacity or efficiency, some through lack of power and others through lack of speed.

One of the major defects in six elevators which did grinding and mixing was that of insufficient grinding capacity. In some instances this problem could have been solved by: (1) Replacement of the old with modern equipment, (2) adding new equipment to that in use, (3) increasing the power, and (4) better distribution of workload.

Several units had automatic scales of too small capacity. If in such instances, the automatic scales were not supplemented by hopper scales, daily volume was materially slowed down, and longer hours (overtime) were required to handle a given volume of grain.

Only two grain distributors were controlled from the work floor. In order to make adjustments to most types it was necessary that a workman go to the distributor floor level. This was time consuming and, unless closely observed, resulted in grain overflow and mixture of grain grades.

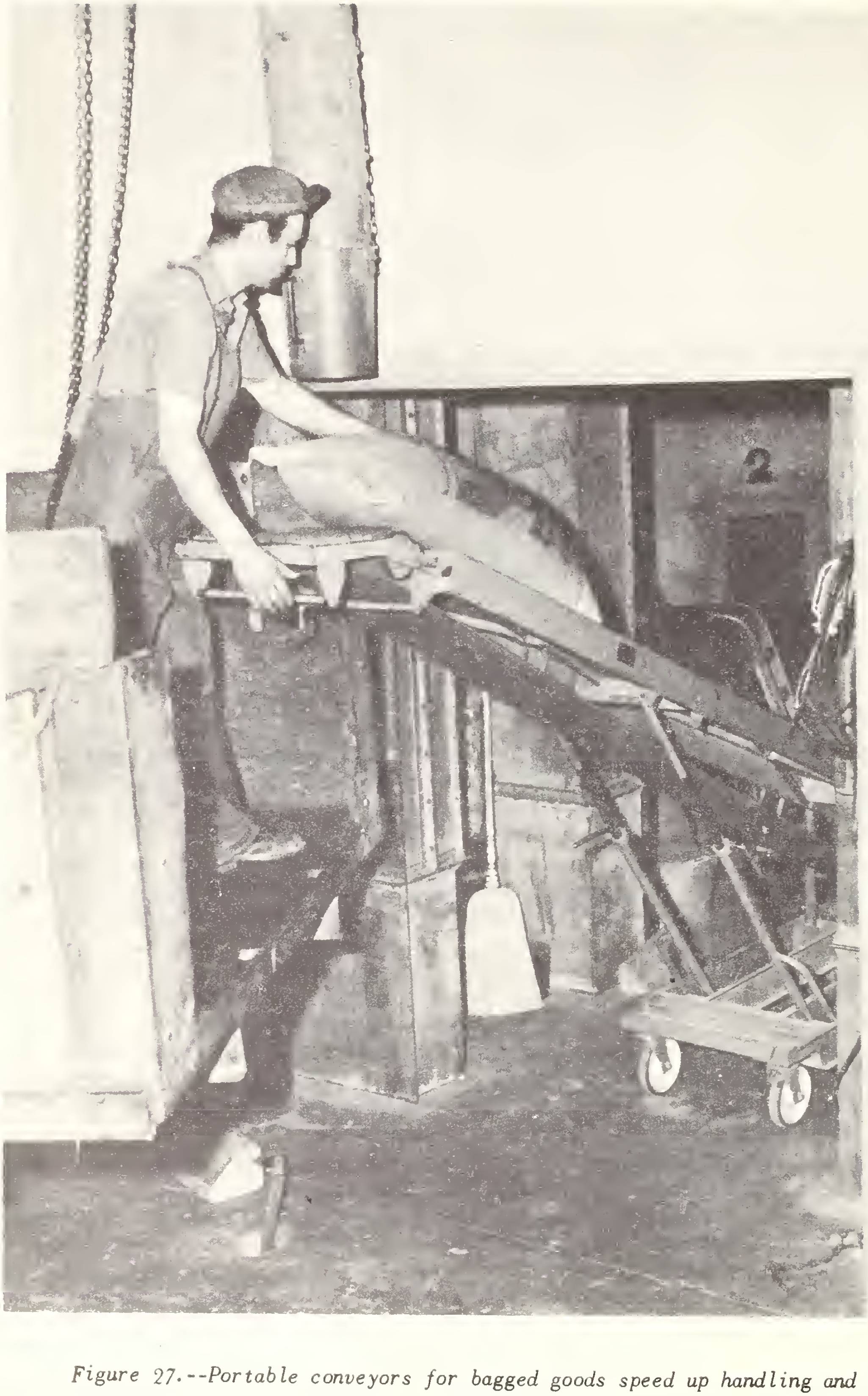

Figure 27.--Portable conveyors for bagged goods speed up handling and reduce costs of operation.

Manlift defects were found in most of the facilities studied. In one elevator a defective manlift was responsible for one death and a serious injury. Most elevators were equipped with manual manlifts, very few being electrified. Five units had no stairway, but depended on the manlift and ladder. In three of these instances the ladder was adjacent to the manlift, and even though the latter was electrified, both areas were inaccessible in case of fire.

The old-fashioned gravity cob chute without a trap was a fire hazard of no mean consequence, particularly if the chute led from the head to the area where the cobs were burned.

The experience of nine managers who used coal toters for unloading coal showed that the absence of this device was a serious defect. The saving in handling time per ton of coal unloaded was well worth the investment.

Defective, insufficient, and inefficient equipment for dust collection as observed in some units reduced morale, contributed to poor housekeeping and respiratory illness, and decreased labor efficiency. Two units had no dust-control equipment, and that of several units was inadequate.

Two units did not use magnets or magnetic separators, and several others did not have magnets in all places where needed.

The absence of cob incinerators in 15 units was a costly defect, which, in most cases, was attributed to location of the elevators within city limits. In some elevators it was estimated that the annual cost of handling and trucking cobs over a period of 2 years would pay the cost of a well-constructed cob incinerator. The factor of safety from fire was another advantage.

One of the difficulties in elevator operation was that of stop-ups in areas of difficult access, such as legs and chutes. The grain discharge fan was helpful in preventing loss of operating time in loading grain cars but most elevators did not make use of this inexpensive device.

The major defect in mechanical operation was associated with the lack of coordination in the capacities of the pieces of equipment moving the grain from dump pits through the elevator to railroad cars. In many elevators the pieces of machinery had been installed through the years to replace other types that had become worn out or obsolete. Some types of handling equipment wore out much faster than others. New individual installations generally tended to have larger capacities than the old, because the current elevator operation required more rapid movement of grain through the elevator than previously. These types of hit-and-miss installations in some elevators had resulted in the use of individual pieces of equipment having different capacities, and the equipment having the lowest capacity acted as a bottleneck in the flow of grain. For example, many of the older type legs, which are somewhat permanent installations and difficult to change, were fed by drags of much higher capacity than formerly, resulting in the need for constant attention to prevent stop-ups and overflows. In elevators built within recent years, with equipment having variable speed controls, the problem was of less significance, but even in these installations this lack of coordination was apparent.

In some cases the lack of coordination may have been caused by installation of motors of too low capacity for proper powering of good equipment, resulting in inefficient operation. Overpowering and increasing speeds of machinery tended to cause excessive wear and breakdowns. Inadequate belting, causing slippage under heavy loads, was apparent.

NEED FOR A COUNTRY ELEVATOR

The purpose of this study, as was pointed out previously, was to obtain information on the types of services rendered by elevators and the facilities and equipment needed by them in performing these services, to determine the factors contributing to their success, to develop criteria for use in determining the need for an elevator in a specific area, and to learn the kind and size needed to handle a given volume of business.

The need for a country elevator can be determined only on the basis of whether or not it would serve the area in a more efficient manner and at less cost than the existing facilities. A new elevator is justified only when it can benefit the area and at the same time be self-supporting. The building of a new elevator will seldom create immediately a new demand for the services which it can perform. The need for the services must already exist, and this need currently may be filled at least partially by existing facilities and functions. Over a period of years, the economies and conveniences associated with availability to producers of an efficiently operated country elevator may tend to encourage the production of grains or develop other requests for elevator services, which would enable the elevator to do a greater volume of business and become a more profitable business enterprise that it was initially.

Information is needed on the following factors to decide whether or not a country elevator is needed in an area.

1. Production of grain

    A. Trends in yearly production as a guide to judgments as to production in the future

2. Disposition of grains produced

    A. Amount remaining on farms for seed

    B. Amount remaining on farms for feed

        (1) Trends in livestock production

        (2) Feed requirements of livestock according to local feeding practices

    C. Amounts and kinds of grain sold from farms

        (1) To country elevators

        (2) To local grain, seed, and feed merchants

        (3) To local flour and grain processing mills

(4) To truckers hauling from farms to outside areas

(5) To other farmers in the local areas without going through either of the channels mentioned above

3. Marketing facilities and structures used by the respective grain handlers, and handling practices

A. Amounts and kinds of storage available

(1) Public storage and private storage

(2) Market movement capacity of existing grain receivers

B. Handling practices for bulk and bagged grain and an evaluation of their efficiencies

4. Grains imported into the area

A. As whole grains for processing

B. As whole grains for sale direct to farmers

C. As bagged feeds

5. Amounts and kinds of custom feed grinding and mixing done currently and methods used

6. Grain prices and margins prevailing in grain marketing, corn shelling, feed mixing and grinding, grain storage charges, and other current grain handling and processing charges

7. Seasonal grain harvesting and movement from farms

8. Seasonal and yearly grain prices to farmers and their relation to prices in other areas producing similar types of grain, and grain buying practices

9. Deterioration in grain quality in existing storage

A. Caused by insects and parasitic infestations

B. Caused by lack of control of moisture content

C. Facilities and methods used in control

In some areas of the United States some of the above factors could be dismissed as not being applicable. For example, weevil infestation is not a factor in the cold spring wheat areas. In some areas where the function of an elevator would be only that of a receiver and shipper of grain, with no probability of carrying on custom-service operations, any inquiry regarding this subject would be unnecessary. In other areas where the problem is in marketing surplus bread grains only, there would be no need for any substantial inquiry into requirements of the livestock for feed grains.

The accumulation, assembly, and analysis of data regarding the above subjects within an area will give a factual basis upon which to make specific judgments and derive answers to the two basic questions: (1) How much grain marketing, custom feed grinding and mixing, and other custom service is done within the area, by whom is it done, how, and at what cost? (2) To what extent could an elevator carry on this business in a more efficient manner than is done at present?

Volume of Grain-Marketing Business Necessary to Make a Country Elevator Operation Economically Feasible

In maintaining and operating a country elevator, a comparatively high percentage of the total cost of operation is fixed charges, which vary only a relatively small degree with the volume of business, at least within reasonable limits. The physical facilities and equipment of an elevator require substantial investment, even for an elevator of a minimum practical operating capacity.

Data regarding the costs of elevator operation in 1949 supply the basis for the estimates of yearly costs of operations for three different sizes of elevators, shown in table 6.

Table 6.--Approximate yearly cost of operating 3 relatively small elevators in Indiana at 1949 price levels

Item	Cost of operating elevators with storage capacity of --		
	10,000 bu.	25,000 bu.	50,000 bu.
	Dollars	Dollars	Dollars
Salary of manager	3,000	3,500	4,000
One helper	1,800	1,800	2,400
Part-time bookkeeper	600	800	1,200
Operation, maintenance, depreciation, taxes	4,000	4,500	6,000
Interest on operating capital at 5 percent	500	600	750
Interest on investment at 5 percent 1/	2/1,000	3/ 2,187	4/ 3,125
Total yearly cost	10,900	13,387	17,475

1/ Estimated costs of new construction from Grain Branch, PMA, USDA.
2/ Total investment at $2.00 per bushel storage capacity $20,000.
3/ Total investment at $1.75 per bushel storage capacity $43,750.
4/ Total investment at $1.25 per bushel storage capacity $62,500.

These illustrations of a method of arriving at an estimate of the yearly costs of country elevator operations are based upon data derived from this Indiana study. The investments are approximations of original construction costs in 1951, and not values of existing structures. In setting up similar budgets in any one specific area, it may be found that costs of the elevator structure and equipment, labor, management, and interest rates are more or less than those indicated above. Therefore, the yearly costs of elevator operation and maintenance in the area may be different from those here illustrated. Also the size in terms of storage capacity must be determined as a factor in investment cost. The foregoing elevator capacities are based upon the grain capacity needed for operative grain storage only, built into the original elevator structure, and do not include supplemental storage structure capacity.

The average margin per bushel of grain received and shipped by the elevators in Indiana was approximately 6 cents. Therefore, the 10,000-bushel elevator would need to handle approximately 182,000 bushels of grain per year to pay the total expenses; the 25,000-bushel elevator would need about 223,000 bushels; the 50,000-bushel elevator would need about 291,000 bushels. These elevators would have physical facilities to handle much more grain during the year than these amounts needed to pay expenses, provided the grain was offered over a period of time that would allow the elevator to receive and ship it.

For example, the elevator with the 10,000-bushel capacity would probably have equipment and facilities to move at least 500 bushels of grain per hour from the scales through the elevator to the railroad car. The 182,000 bushels of grain that must be marketed to pay the yearly expense of the elevator could be moved through the elevator in the equivalent of about 45 days of 8 hours each. The elevator with the 50,000-bushel storage capacity would reasonably have a movement capacity of 1,000 bushels per hour. The 291,000 bushels of grain necessary to pay the expenses of this elevator could be moved through the facility in the equivalent of 36 days of 8 hours each. Obviously, with a margin greater than 6 cents per bushel, less volume, and consequently less time, would be needed to meet expenses. With a smaller margin than the 6 cents per bushel, a greater volume would be needed. These data emphasize the fact that, even with a margin of 6 cents per bushel, the movement of grain through an elevator gives a high return per hour when the plant operates at near capacity. They show also that in nearly all country elevators the equivalent of many months of idleness face the elevator which performs only the function of marketing grain.

The budgets presented are calculated on the basis of year-round operation. In some highly specialized grain-producing areas, where a country elevator serves only as a receiver and shipper of surplus grain during the current harvesting season, the elevator may remain open 30 to 40 days and be closed during the remainder of the year. Management and labor under these circumstances would be charged only for the short operating period, if they could be hired on this short-time basis; costs of operation would be lower, and a different budget would have to be calculated as a basis for determining the amount of grain needed for marketing to offset expenses.

Additional Income from Custom Services

As indicated previously, judgments regarding the need for a country elevator in a local area may be made only after an evaluation is made of the amount of grain entering commercial channels in the area. If it were determined that 150,000 bushels of grain could reasonably be expected to move through an efficiently operated elevator, the income from this marketing of grain at a margin of 6 cents would be $9,000. If the elevator were similar to the elevator of 10,000-bushel capacity for which the budget of expenses was made, additional income of $1,900 would be necessary from some source to pay expenses. This additional income might be derived from performing custom services, such as grinding and mixing feeds for local farmers. The addition of a grinder and mixer, however, would involve an additional investment of perhaps $2,500, the amount depending upon the types and capacities of the equipment installed. The power cost would increase because of the use of additional equipment and the greater use of equipment already installed for handling whole grain. The manager and labor would still have time available to carry on well-chosen lines of side-line merchandising.

In the elevators studied the average income from grain marketing was 23 percent of all receipts, from custom services 11 percent, and from side-line merchandising 66 percent. No elevator could have survived from the income derived from the grain-marketing operation only. Custom-service income, although not as great as the income from the other two lines, was rather constant during the year. These services usually made use of labor and facilities otherwise not employed, did not add materially to current expenses, and, if performed satisfactorily, provided an excellent point of contact with farmers and aided in merchandising supplemental feeds and livestock supplies.

In some areas it is possible that a part of the grain-marketing business which could be done by an elevator would consist of moving imported grain through the elevator on its way to farmers or processors. This type of reverse movement can be handled by standard elevator equipment, the only additional equipment necessary probably being a suction unloader or a rail car grain dump, if the grain is received in bulk by railroad car.

Possible income from other types of custom services which might be performed by an elevator should be investigated. In some areas grain and seed cleaning, corn shelling, grain drying, and the public storing of grain may offer possibilities. The elevators studied found very little demand in their areas for grain-storage space, only about 14 percent of the available space being rented and bringing in revenue.

Income from Possible Side-line Merchandising

In most areas where the building of a country elevator is contemplated, the decision as to whether an elevator should be built will be made largely on the basis of the amount of grain marketing business needed to justify the investment. Obviously, in an area where receiving, handling, and shipping grain is the only enterprise of the elevator, the receipts from this operation must be sufficient to pay all expenses. In another area an elevator engaged in marketing grain and performing custom services must obtain yearly receipts from these two operations sufficient to pay the cost of operation, with the receipts from grain marketing being about two-thirds of these costs. Potential receipts from side-line merchandising should be disregarded at the outset because these receipts, in most existing elevators were brought about by economic pressure on facilities already built and doing business but with a lack of sufficient business to support themselves, thereby forcing the operator to look for other income. Side lines in elevators studied were the result of trials and experience in handling various items through a period of years in their local communities. The financial success of a new elevator constructed for grain marketing should not be predicated upon any anticipated income from side-line merchandising. Although receipts from side-line enterprises carried on by elevators in Indiana made up two-thirds of all receipts in 1948 and 1949, it has taken many decades for these elevators to develop the business which gives this income, and their previous ventures, pioneering, and losses in this field are not apparent in current data.

As stated previously, the contemplated receipts from grain marketing and custom servicing in a newly established elevator should be sufficient to pay the total expenses, the receipts from grain marketing being two-thirds of this amount. If a survey of the anticipated receipts indicates a rather good potential business in custom services, with probable maximum receipts from grain marketing making up less than 50 percent of the total receipts from the two enterprises, the question arises as to whether a country elevator, with its high cost of construction, should be built at all, or whether it would not be preferable instead to build a facility at much lower cost to handle custom services and side-line merchandising.

Country elevators are permanent, costly structures. The buildings cannot be moved satisfactorily from one location to another. They are built to last for many decades, given reasonable maintenance and repair, but their equipment may become obsolete and outmoded. They have very little value as a structure for carrying on any type of business other than the handling of grain. Custom services are usually profitable because some elevator facilities and elevator labor can be used. Such custom services also can be used to build up good will with farmers, thereby increasing the probability of having those farmers as surplus grain suppliers or buyers and increasing the grain-handling business. Even so, the comparatively high-cost country elevator must justify its construction and equipment cost in large part on the basis of its grain marketing function.

Of course, the alert management necessary for successful grain-marketing and custom-service operations will also have an eye for opportunities in side-line merchandising as they arise. The side-line enterprises best suited to one area may be quite different from those in another. Therefore, it would be highly impractical to suggest specific lines of merchandising which could be successfully carried on in a specific area.

FACTORS FOR CONSIDERATION IN DETERMINING THE STORAGE CAPACITY OF A PROPOSED COUNTRY ELEVATOR

The storage capacity of an elevator is the amount of grain that can be stored in it at one time. Storage bins in country elevators may be used primarily for two purposes, (1) operative storage and (2) public storage. The storage capacity of the country elevators studied varied from 11,000 to 100,000 bushels. A majority of these elevators were built many years ago, and their capacities were determined by the anticipated storage needs of the areas served by them at that time. Through the years the storage of grain in these country elevators as a public service for any appreciable length of time has decreased, and in a majority of cases grain storage as a service to farmers has largely disappeared. Also, it was the policy of practically all independent country elevators studied not to store grain for any considerable period of time on their own account. Except in peak seasons of grain harvesting and marketing, much of the capacity of the elevators remained unused throughout the year.

Operative Storage

Operative storage space is that space needed for the temporary placement of grains so that desired amounts of different grains of different grades may be assembled in amounts sufficient for shipment or sale. Operative storage space may also be necessary in the holding of grains for elevator processing, such as drying, cleaning, blending operations, etc. Elevators receiving several different kinds and grades of grains at the same time require many bins, and the amounts received at one time will influence the volume of such space needed. The amounts of grain that may be held by the elevator for sale to farmers in custom-service operations also will influence the kind and amount of space needed.

Each type of grain produced in a specific area has its own seasonal movement through the local elevator. Cash grain crops, such as wheat, soybeans, and flaxseed, move largely from farms to elevators at harvest time. In an area where wheat is the only cash grain grown, a wheat marketing season for a particular elevator may cover a period of less than 1 month, with the peak load coming perhaps within a period of 2 weeks. If adequate railroad cars are available, the volume of grain accepted at the elevator during 1 day would be regulated by the smallest volume capacity of the dump pit and drags, elevator legs, cleaners, loading chutes, and other facilities through which the wheat would flow on its way to railroad cars or trucks. If the facility with the smallest capacity handled 750 bushels per hour, 15,000 bushels of wheat could be loaded in 20 hours, or about 10 cars of 1,500 bushels each. During a car shortage an elevator storing 100,000 bushels could carry 5 or 6 days' receipts.

In more recent decades, the business of storing grain for extended periods after leaving farms and Commodity Credit Corporation bins, has become concentrated in subterminal and terminal market centers, with country elevators using less and less of their grain-storage space for any substantial length of time. Lines or chains of country elevators under one over-all management may use the storage capacity of their respective country elevators at times for regulating the flow of grain to terminal elevators, especially during periods of heavy market supplies. Independently owned country elevators, however, in a majority of areas have much less demand for their storage space and have abandoned the use of their space for storing grain over long periods of time on their own account because of financial risks involved. The majority of farmers make little use of local elevators in storing their grain.

In the areas studied in Indiana, wheat and soybeans were the principal crops grown primarily for cash. Wheat was harvested in July, and soybeans in October and November. Corn and oats were grown primarily as feed crops for livestock, but the levels of production were usually such that surpluses above livestock needs were produced in normal years. Some farmers produced corn above their own needs to sell to neighbors or to the country elevator at harvest time in October and November; some farmers stored their corn on their farms until they were able to determine whether or not they had more corn than necessary to feed their livestock and sold their surplus in February before the tax assessment deadline of March 1; other farmers waited until April, May, or perhaps July before they sold their surplus. Thus, corn moved through the country elevators during the period from October to July, with the largest volume by months, coming in October, November, and February. Only relatively small amounts of oats moved into the elevators for cash sale.

Rated Storage Capacity

With this staggered system of grain movement to market during several months of the year, and with the country elevators doing very little storage business, an elevator of small storage capacity often handled and moved to market as much grain during the year as one with a much larger storage capacity. In other words, under the circumstances found in this study, rated storage capacity in an elevator was not an indication of its capacity to market grain. The elevators in the group having the smallest rated capacities marketed on the average more than 15 times their rated capacities, and those in the group having the largest capacities averaged marketings of about 5 times their rated capacities. The extremes for individual elevators were 34 times capacity in one small elevator and 2 times capacity in one large elevator.

The shortage of railroad cars, when needed during peak harvesting periods at country elevators, was one of the principal reasons given by managers of smaller elevators for the need of additional grain storage space. With large storage capacity, an elevator was able to accept a maximum amount of grain from farmers during a short time, temporarily using elevator storage in place of unavailable railroad cars.

In new construction, the investment in a small-capacity elevator is, of course, much less than the investment in a large-capacity elevator. Unless the additional storage space above that needed to store grain temporarily in the marketing process can be rented to bring in revenue, the investment in the added storage space is a distinct burden on the business. Most of the elevators included in this study were constructed years ago when the storage of grain by country elevators was a somewhat common practice because of the then existing type of farming in the areas where located. In most instances, their ownership has changed hands many times since their original construction, at values based upon factors other than grain-storage capacities. Therefore, many large-capacity elevators did not represent a considerably greater investment by the present owners than did some small elevators. However, if new construction is contemplated, the high cost of large-capacity elevators would tend to eliminate such types from the picture in areas where the storage of grain in country elevators is not a common practice and where the marketing of grain extends over several months of the year. In Indiana the volume of operating storage space used normally by the respective elevators studied varied from 5,000 to 20,000 bushels, depending upon the volume of grain handled and the efficiency of management.

In general, if the seasonal flow of grain from farms to the elevators is such that the volume during the highest marketing period can be accepted and moved on to market without any bottlenecks, such as are caused by a lack of railroad cars or other transportation, the storage capacity of the elevator may be kept to the minimum needed for the accumulation of types and classes of grains suitable for shipment. If the grain needs drying or fumigation for weevils, or turning to maintain condition, more operative storage is needed. If the peak load of grain receipts from farmers is greater than can be promptly moved from the elevator, more storage capacity is needed in order to continue to accept grain from farmers.

On the basis of an average ability to move 850 bushels of grain per hour through the appropriate facilities, from dump pits to railroad cars or trucks, the 18 elevators handled a volume of grain equal to about 50 days' operation of 8 hours per day. On a 5-day week basis, this volume would require that the elevator operate 10 weeks for the grain-marketing function during the entire year. In other words, only 10 weeks, or 20 percent of the time of the elevator in one year, was needed to perform the normal handling operations necessary in the movement of the marketed grain.

Of the smallest capacity elevators studied, the one doing the greatest volume of business in grain marketing in a year could have moved that volume through the elevator in 47 days. Of the larger capacity elevators, the one handling the greatest amount of grain could have moved its volume in less than 50 days. This elevator had relatively high-capacity equipment.

These data indicate that, if no bottlenecks occurred in the grain-marketing operation performed by country elevators, such as a lack of railroad cars at the time they are needed, the elevators studied had little use, and in some cases no use at all, for grain-storage capacity above that needed for moving the volumes and varieties of grain brought to the elevator for marketing. When farmers bring corn and soybeans or two or more grades of wheat or any other grain to an elevator at the same time, separate storage bins must be available for handling the various types and quantities until sufficient quantities may be assembled for carlot shipments or for blending grades and other purposes. Elevator managers indicated that if adequate empty railroad cars were available when needed, operative storage capacity of 10,000 to 25,000 bushels would be sufficient to handle all peak loads of grain in the area studied, which, as pointed out previously, has a somewhat extended seasonal pattern of grain marketing.

Variations in Producing Areas

Contrasted to this situation in Indiana, however, would be the entirely different marketing situation of a country elevator in, perhaps, western Kansas, where wheat might be the only grain marketed. Within the production area serviced by an elevator, wheat would ripen and be harvested, in normal years, during a maximum period of about 20 days. In an elevator with a handling capacity of 1,000 bushels per hour, operating for 18 hours a day, the 20-day output would be 360,000 bushels. Unless railroad cars of 1,500-bushel capacity were made available at the rate of 12 per day, an elevator having storage capacity of 100,000 bushels could operate on a margin of about $5\frac{1}{2}$ days' receipts into storage. Railroad cars or other transportation would have to be made available at the time needed, or the elevator would be obliged to refuse wheat from farmers when the storage space was full. In this type of operation, a country elevator must do practically all its yearly business in grain marketing within a very short period, the elevator remaining comparatively idle for perhaps 11 months of the year, unless farmers store their grain on their farms until the elevator can handle it. If storage space could be built at a cost small enough that the increased volume of grain handled would give an income sufficient to warrant the investment, the building of such storage space would be economically feasible.

The probable availability of an adequate number of railroad cars or other transportation at the right time is of primary importance in planning grain-storage capacity. If cars and motortrucks are available, an operating cushion of storage may be all that is necessary. If adequate transportation is not available, any increased volume of harvest-time business brought about by the provision of storage space must bring a profit sufficient to meet its cost.

Climatic Factors

Long storage of grain in warm, moist climates, where insect and parasitic infestation is high, may be accompanied by serious losses unless adequate measures are taken to prevent them. The facilities and equipment necessary for the treatment of grains going into storage and for treatment within storage were not commonly found in the country elevators studied, the climate being such that insect infestation of grains is not common. Therefore, adequate data could not be obtained as to the most efficient facilities and procedures to be used in the treatment and prevention of grain infestation. Whether the design of existing country elevators would give the most favorable arrangement for treatment for insects and parasites in areas where heavy infestation is common is subject to further inquiry. Any design and arrangement of physical structures and facilities to carry out public storage functions in warm, moist climates must necessarily take this important factor into consideration, as it relates to increased costs for space, equipment, and operation.

CHOOSING A LOCATION FOR A COUNTRY ELEVATOR

In choosing a location for a country elevator several factors should be considered. The most important factors are: (1) Accessibility of the site to transportation facilities, (2) convenience to customers, (3) availability of power, (4) a location outside of congested areas, (5) adequate drainage, and (6) adequate land area for present needs and for expansion.

Accessibility to Transportation Facilities

The transportation of grain from country elevators to subterminal and terminal markets is mainly by railroad. In recent years the volume of motortruck transportation has increased greatly in some areas. Accessibility to transportation is of major importance in determining the location of a country elevator.

The availability of an adequate supply of empty cars to the elevator and the timely movement of loaded cars from the elevator often determined the volume of grains that could be handled during the peak period of grain marketing. Elevators which were located on spur tracks leading directly from one or more main line railroads tended to receive the best railroad services. Switching services by railroads tend to be most efficient and timely at those elevators where such services can be performed with the least effort. Supplies of empty cars to and movement of loaded cars from an elevator located on a branch line railroad, carrying relatively small amounts of traffic, may tend to be somewhat erratic and undependable. At peak seasons of grain marketing, an elevator may be called upon to operate at highest capacity each day for several days, taking time out only for the upkeep of machinery. Daily railroad service, and at some elevators twice-daily service, in supplying empty and moving loaded cars may be necessary in order to move this volume of grain. Otherwise, acceptance of grain from farmers must be refused, unless adequate storage is provided.

An elevator should be located at a point which can be easily reached by motortruck from all directions. A high percentage of all grains and other items received by a country elevator arrive by motortruck. All customers use highways to get to the elevator. Therefore, the more convenient it is for farmers and other customers to reach the elevator, the more customers the elevator will have, other factors being equal. Experience has proved that farmers with truck or trailer loads of grain will travel many miles over a good hard-surfaced road to avoid a short stretch of bad road. In Indiana, some elevators lost business because competing elevators were located on more easily traveled all-weather roads and highways.

As long as railroad cars were used exclusively for the shipment of grain from elevators to terminal, subterminal markets or processors, the importance of the location of an elevator on a through highway direct to a subterminal, terminal market, or a processing plant was not of major consideration. However, in recent years, the use of large semitrailer trucks for this job has greatly increased in some areas. In Indiana it was found that the use of trucks for transporting grain from elevators to subterminal markets, especially during the peak grain-marketing season, helped to solve the problem of the shortage of railroad cars. Thus, elevators were able to move grains that otherwise could not have been accepted from farmers. If the somewhat chronic shortage of railroad cars during peak marketing seasons persists in the future, elevators so situated with respect to terminal and subterminal markets that they can economically utilize truck transportation of grain will enjoy a competitive advantage.

Convenience to Customers

It is doubtless true that an elevator may be located at a point easily accessible to farmers, but outside a congested area, and carry on a grain-receiving business and perform custom services. However, when an elevator moves into the general field of merchandising and attempts to supply the local people with various types of products for which there seems to be a profitable demand, the location of the elevator with respect to the prospective buyers may be worthy of consideration. If the prospective buyers are only those farmers already patronizing the elevator, the convenience of location may be of less importance, because such farmers are already in the habit of going to the elevator. The main problem then is to compete successfully with other local suppliers of the same commodities. However, if it is anticipated that prospective buyers shall be the local citizens in general, the location of the elevator must be such that these citizens can conveniently get to it to make purchases. In selecting a location, with the probability that certain types of merchandising other than grain handling and farmer services will be carried on, the convenience to such prospective customers should be considered. As indicated elsewhere, the successful operation of independent country elevators studied seemed to center around selling many items of merchandise not particularly related to grain elevator operations. Data indicate that most elevators in the areas studied could not have existed for any length of time without the profits from these side-line operations. Therefore, in locating an elevator within an area, the convenience of the location in relation to the buying public is a factor for careful consideration.

Availability of Power

Adequate and unfailing power is a necessity in efficient elevator operation. Experience has indicated that the use of electricity for power in an elevator, with its many types of machines having their own motors, usually provides a flexibility, convenience, and economy of operations not possible with steam, oil, or gasoline motors. In the early years of elevator operations, however, nearly all were operated without electricity. Some used steam engines, burning the cobs and waste from the elevator as fuel; others used various types of oil, gas, and gasoline engines and operated for years with these. It is significant, however, that as electricity became available, nearly all elevators were converted to its use.

In other words, an elevator can be operated successfully without electricity, but electric power is so convenient, flexible, labor-saving, and adaptable to elevator operation that, in selecting a site, the availability of electric power is worthy of serious consideration. Other factors being equal, the site selected should be that site where electric power is available in sufficient amounts to run the elevator, at maximum capacity even at the expense of installing adequate feed lines of some length. All modern elevator equipment is made primarily for electrical power, although it can be adapted to suit other types of power. The line-shaft belt system of power transmission, which is necessary with only one engine for power, tends to limit the efficient arrangement of elevator machinery, takes up much space, requires much maintenance, and is generally unsatisfactory as compared with the individually electric-powered units.

A Location Outside of Congested Areas

In addition to the economies associated with the location of an elevator convenient to railroads and highways, its location with respect to its immediate environment may have considerable effect upon the costs and convenience in operation. Within a congested area the possibility of securing a site of a size and shape suitable for a well-planned elevator development, with room for expansion, would be much less than in a non-congested area. Also the original investment in the former site would be much greater. If the site were located within an incorporated town, current taxes would probably be greater than if it were outside. The burning of waste materials, such as corn cobs and dust, may be prohibited within city limits and, if not prohibited, may become at times a nuisance to local citizens and create ill-will. Some elevators in the areas studied paid substantial sums for the hauling of waste because the elevators were located in populated areas where incinerators were not permitted. Many custom-service operations in elevators lead to the production of dust, which can become a nuisance to people living nearby. Some elevator managers were using elevator waste as a feed for livestock, with feed yards located near the facility, which would not have been permitted in population centers (figs. 28 and 29). During certain seasons of the year, traffic to and from an elevator may contribute greatly to local traffic difficulties and constitute a hazard to elevator customers and others. This is true for both street and railroad traffic. Many country elevators built years ago now find themselves in the middle of a business district which has grown up around them, and such a location contributes to increased costs and inconvenience in operations.

Adequate Drainage

Unless the topography of the site allows otherwise, nearly all elevators are built with the bottom of the boot pit below ground level, and often below the basement level of the elevator. Water in the boot pit, caused by surface drainage or seepage from below ground level, is one of the most serious and costly hazards with which many elevators

Figure 28.--Hogs can advantageously use waste byproducts from grain marketing and processing operations as part of their feed supply.

Figure 29.--The greater part of the feed for these beef cattle consisted of corncobs and husks, grain dust, seeds and shrunken grain from grain cleaners, and other byproducts of grain marketing and processing. Considerable space must be available near the elevator for this type of side-line operation.

must contend. Costly efforts to correct the situation are not always successful. Therefore, in the selection of an elevator site, adequate surface and sub-soil drainage are a requisite if future trouble is to be avoided. Waterproof concrete on a well-drained site has usually proved the most adequate means of preventing water in the boot, platform scales, and dump pits.

Adequate Land Area

The site selected should be sufficient in size to allow for the proper layout of the structure to be built, initially as well as for future expansion of buildings and structures, and to allow for the free and orderly movement of traffic and parking of automobiles, trucks, and trailers. The site should border a spur track long enough to accommodate perhaps from 12 to 16 railroad cars. In many instances, the eventual expansion will be most desirable along the spur tracks. For a rather small elevator, the site should contain at least 2 acres, in most cases extending rectangularly along the spur tracks but deep enough to allow for proper layout and for traffic and parking space. If it is contemplated that the side lines may include a lumber business or the feeding of cattle from elevator waste, or other types of businesses requiring substantial space, allowance should be made for enough area for such side lines in selecting the site. (See figs. 28 and 29.) Any judgments concerning the amount of space needed in an elevator site should be in the direction of too large rather than too small a site. The operations of many elevators at present are seriously hampered, and some types of operations are impossible because of the lack of space for expansion.

DETERMINING TYPES OF FACILITIES NEEDED AND THEIR PLACEMENT ON THE SITE 5/

Labor expense in the operation of a country elevator is the greatest single item of expense and is usually more than half the total, the proportion depending upon the volumes and types of business carried on. Therefore,the placement of structures and facilities in such a way that labor can be utilized in the most efficient manner is of primary importance. Convenience to customers, whether in grain marketing, custom services, or side-line merchandising, is another factor of great importance in the layout of a country elevator.

In considering the types of facilities needed and their placement on the elevator site, the following points are important.

Main Elevator Structure

The main elevator structure should be built adjacent to the railroad spur for loading and unloading cars, with trackage placed in such a way that loaded cars may be moved down-grade on the spur in the direction of the main line.

Nearly all of the early country elevators built in the United States were of wood. Destruction by fire is the greatest single hazard to them. A high percentage of all new country elevators has been constructed to replace elevators that have burned. This fire hazard has been one of the main factors resulting in the use of concrete for new elevator construction. Cost estimates encouraging new elevator structures can be built of concrete at only slightly more than the cost of building similar plants of wood in most areas. The costs of machinery and equipment are approximately equal for the two types of buildings. Fire insurance rates on structures and equipment are substantially less when the structure is built of concrete. The cost of building a concrete elevator as compared to the cost of wood construction should be determined locally in the individual case, but experience in recent years has indicated that in most instances the added cost of concrete construction is more than offset by the benefits derived from it.

Office

If the elevator does grain marketing only, the paper work and other office work is not heavy. Therefore, the office can be small and, at the sacrifice of other conveniences, may be located within one corner of the elevator structure.

5/ A detailed study of the best arrangement of the different pieces of mechanical equipment to promote maximum operating efficiency was not included in this project.

If the elevator does grain marketing and custom servicing, the office work can still be held to a minimum, but an accounting system must be kept, charges figured, money received and paid out, and a telephone maintained. Although additional office space is needed for custom services, the space needed can be small and may be located, at least temporarily, adjacent to or in the service work-floor area.

When side-line merchandising is a substantial part of elevator business operations, the need for much greater office and display and salesroom space is apparent. This office space is designed for the storage and display of merchandise, convenience of customers, and efficient use of labor. A sales counter, an inner office where private business may be transacted, shelves and cases for the placement of stocks, plus room for the movement of customers and salesmen are provided. Where side-line merchandising is carried on, such individual types of merchandising are usually carried on in competition with other merchants in the same area selling the same merchandise. The facilities for the display of products and for the convenience of customers, many of whom probably will not have business in the elevator structure, must make purchasing at the elevator attractive. The office must be easily accessible by car or truck and have ample parking space available, but still be close enough to the main elevator structure and feed-mixing floors so that the manager can have easy access to them for performing and supervising elevator labor. Elevator noise, dust, and traffic at times can prove a nuisance and a handicap in conducting office business and selling certain side-line merchandise.

In Indiana the starting of custom services by country elevators, primarily consisting of grain grinding and feed mixing, in most cases resulted in stocking of protein feed ingredients and other types of supplements for sale to farmers for inclusion within the feed mix. As this custom servicing increased, accompanied by various types of side-line merchandising, the tendency was to segregate the office from the noise, dust, and activity associated with custom servicing. As other side-lines were added, better and larger office space and salesroom space became necessary. In many instances the volume of side-line activities increased to the point where new office buildings became necessities in order to provide space for sales and display rooms apart from the main elevator structure. By the use of separate buildings, side-line activities did not create a handicap to the movement of grain to and from the elevator. Neither did the noise, dust, and traffic congestion of the grain-marketing and custom-servicing activities interfere with office and salesroom activities.

Truck Scales

Motortruck scales must be located alongside the office. The scale platform should be long enough and have a capacity to weigh loads in semi-trailer trucks. Scale readings should be taken inside the office, and office windows should overlook the scale platform. Scale platforms should clear the office wall by at least 3 feet to allow for clearance of wide loads. Movement of trucks onto and off the scales should not require short turns or steep grades, and movement of loads from scales to dump pit should be in a space sufficient to eliminate short turns. The first scale installed should have a capacity to weigh the heaviest probable loads in the longest probable trucks.

As custom services and side-line merchandising increase, the need may arise for another truck scale, perhaps of smaller capacity, to expedite the movement of smaller loads and empty trucks so as to render more prompt and efficient service to customers. This second scale also should be adjacent to the office so that readings can be made inside the office or salesroom. In the elevators studied, the second scale usually was located on the side opposite the first scale, or at a 90° angle, with a window giving a view of the scale platform and the load.

Custom-Service Building

The work-floor space in the main structure of small country elevators usually was not sufficient for the equipment used in performing custom services. Consequently, when elevators which had served only as country grain concentration points increased their services to include custom grinding and mixing, an additional structure was necessary. This structural improvement sometimes was added as an enclosure at the side of the main elevator building opposite the spur track, or along the spur at one end of the elevator.

In the elevators studied, ear corn brought to the elevator for grinding and mixing moved through the regular elevator equipment for shelling and separation before moving to the grinder. Ear corn, at times, went directly from the dump pit by a short leg to the grinder for corn and cob meal. Because these custom-service operations nearly always require the use of some equipment located within the elevator structure, the custom-service building must be located adjacent to the main structure so that the movement of whole grains for grinding and mixing may be rapid and efficient. Many farmers purchase high-protein ingredients from the elevator for inclusion in mixing feeds; therefore, these ingredients should be stored adjacent to or in the custom-service or feed-mixing building.

The custom-service building or enclosure should have easy access by truck to adjoining covered platforms at truck-bed height for the loading of bagged goods into trucks from the work floor. Some bulk feed mixes are hauled in trucks by farmers, such trucks being loaded by chute from the feed mixer.

Supplemental Storage Structure

Because of the comparatively high cost of grain storage space when built into the original structure of a relatively small country elevator, some grain storage space which may be greatly needed during peak marketing seasons may be provided in a structure built near the main building. This structure, whether it be of metal, wood, or concrete, should be close enough to the main building that it could be filled through grain chutes from the main elevator structure. It should have a screw or chain drag built into the floor for the movement of stored grain back to the boot pit in the main structure, from where it can be moved to railroad cars or other outlets by use of the existing elevator machinery.

In producing areas where grain moves rapidly from combines to elevators during a short period of time, the need for this supplemental storage to enable an elevator to receive grain may be very pronounced. If the structure is to be used only for grain storage—either as temporary storage of grain by the elevator during peak receipts or for public storage during the year—one of several types of structures available in knockdown form, usually of metal construction and having a wide range in storage capacities, could be used. This building could be used for operating storage, which usually would be of short duration, and during the remainder of the year for storage of merchandising materials and as an overflow workroom.

Power Facilities

The power requirements of a country elevator vary according to the number of units of power machinery installed and the size and operating capacity of the machinery. A relatively small country elevator having a grain-marketing capacity of about 500 bushels per hour would require power on the following units of equipment: One hoisting device, two drags, two legs, one scalper, one carload grain blower, and one dust and trash collector and blower. The total power necessary to operate this equipment would be approximately 65 horsepower. If ear corn is received by the elevator for marketing or shelling, a corn sheller having a capacity of 500 bushels per hour would require a minimum of approximately 30 horsepower, and a cob blower would require 7 horsepower.

In an elevator doing custom servicing, a grain grinder and a feed mixer with capacities of 4 tons per hour would require about 65 horsepower. A corn cracker, if added, would require 5 horsepower. In general, a small country elevator performing both grain marketing and custom services would require a minimum of between 150 and 175 horsepower. The capacity of the power installation whether electric, diesel, steam, or water, should be based upon the total power needed in the elevator if all the powered equipment were operated at the same time. Electric feeder lines, belt-line shafts, and other types of equipment transferring power from its source to the respective types of equipment should have sufficient load capacity to operate the equipment at optimum capacity and efficiency. Overloaded and inadequate electric lines and overloaded electric motors are two of the principal causes of inefficient mechanical operation in country elevators and in many cases constitute a definite fire hazard.

Grain Drier

In some areas a grain drier has proved to be a necessary part of the equipment of a country elevator, especially since the advent of the combine harvester and corn picker and their turnout of grain with a moisture content higher than was the case when grain was dried in the shock before threshing. Discounts on high-moisture grain are heavy, and in the more humid areas the practice of drying grain has proved economical, resulting in improved grades and higher prices. The drying of such high-moisture grain usually has more than paid the cost.

In climates where a relatively high percentage of the grain from farms may have a moisture content above the maximum tolerance in United States grain grades, the maintenance of quality in such grains when stored, and the non-acceptance at most terminals of high moisture grain, presents many problems, and the incorporation of a grain drier into the normal handling of grain in the elevator may be practically mandatory. Generally speaking, possible high incidence of weevils or a parasitic infestation also will accompany high-moisture content in humid climates. Certain systems of relatively high-temperature grain drying, such as that which may be used for grains destined for dry processing, also will help to eliminate insects and various other larvae. Low-temperature systems of drying, such as may be necessary for grains to be used for seed, may not affect insect infestation to any substantial degree.

The capacity of the grain drier to be installed in an elevator, therefore, must be determined by local conditions with respect to: (1) Volume of wet grain to be dried, (2) amount of moisture in the grain, and (3) market demands for grain in terms of relatively high or low moisture content.

In Indiana, country elevators having driers found that in wet harvest years when the bulk of the grain coming to the elevator needed drying, their driers were of much too low capacity. In dry harvest years the driers were not greatly needed. In any local area the incidence of dry harvest years as compared to wet harvest years would be a major factor in determining the feasibility of installing a grain drier in an elevator and also in determining the capacity to install. Obviously, the installation of a high-capacity, high-cost dryer in an elevator in an area where it would be used only one year in every five may not be economically feasible.

The concentration of heat in a grain drier has made it desirable that the drier be located outside the main elevator structure to minimize the fire hazard. Elevator power machinery, combined with gravity, should move the grain to the drier and deliver it to the elevator bins or to transportation facilities. When properly constructed, driers reduce the temperatures of all grains passing through them so that they are cool enough for bin storage. The heat unit of the drier should be isolated in such a manner that, in the event of faulty operation and fire, the main elevator structure will not be affected, either by the fire itself or by hot and fired grain going into the elevator bins.

Cob Incinerator

Country elevators doing a considerable amount of corn shelling find that the disposal of cobs and husks involves considerable hauling costs. In recent years, if not prohibited by city ordinance, the use of an incinerator to dispose safely of cobs, husks, and refuse assembled by the dust collector system has proved to be an economical method. The incinerator should be at a safe distance from the other structures, but close enough so the waste may be blown through a metal chute from the cob and corn separator, usually located in the head house of the main elevator structure. The burner should be made of masonry, lined with fire-brick, have a screen cover, and be so constructed at the base as to allow for a draft sufficient that the waste may burn promptly with a minimum of smoke. The chute should be provided with a back-draft check to prevent sparks from following the chute from the burner back to the elevator. Usually the end of the chute is about 2 feet from the opening into the incinerator; the cobs and other refuse enter the side of the burner near the top and are carried over the gap by the velocity of their descent in the chute. In areas where a need exists for cobs and the receivers haul them away from the elevator, a small bin is usually provided either as a part of the main facility or in a nearby structure planned and built for the specific purpose, from which trucks may be loaded by gravity.

Possible Layout of Facilities

A plot plan of a small country elevator for marketing grain only is shown in figure 30. Another plot plan for a country elevator having structures and facilities designed for marketing grain, performing custom services, and selling merchandise is shown in figure 31. The different kinds and names of the respective types of mechanical equipment usually installed in a country elevator are indicated in figures 8 and 13, and are discussed in some detail on pages 19 to 47. A detailed study of the arrangement of the different pieces of mechanical equipment within the elevator structures in order to promote optimum operational efficiency was not included in this project.

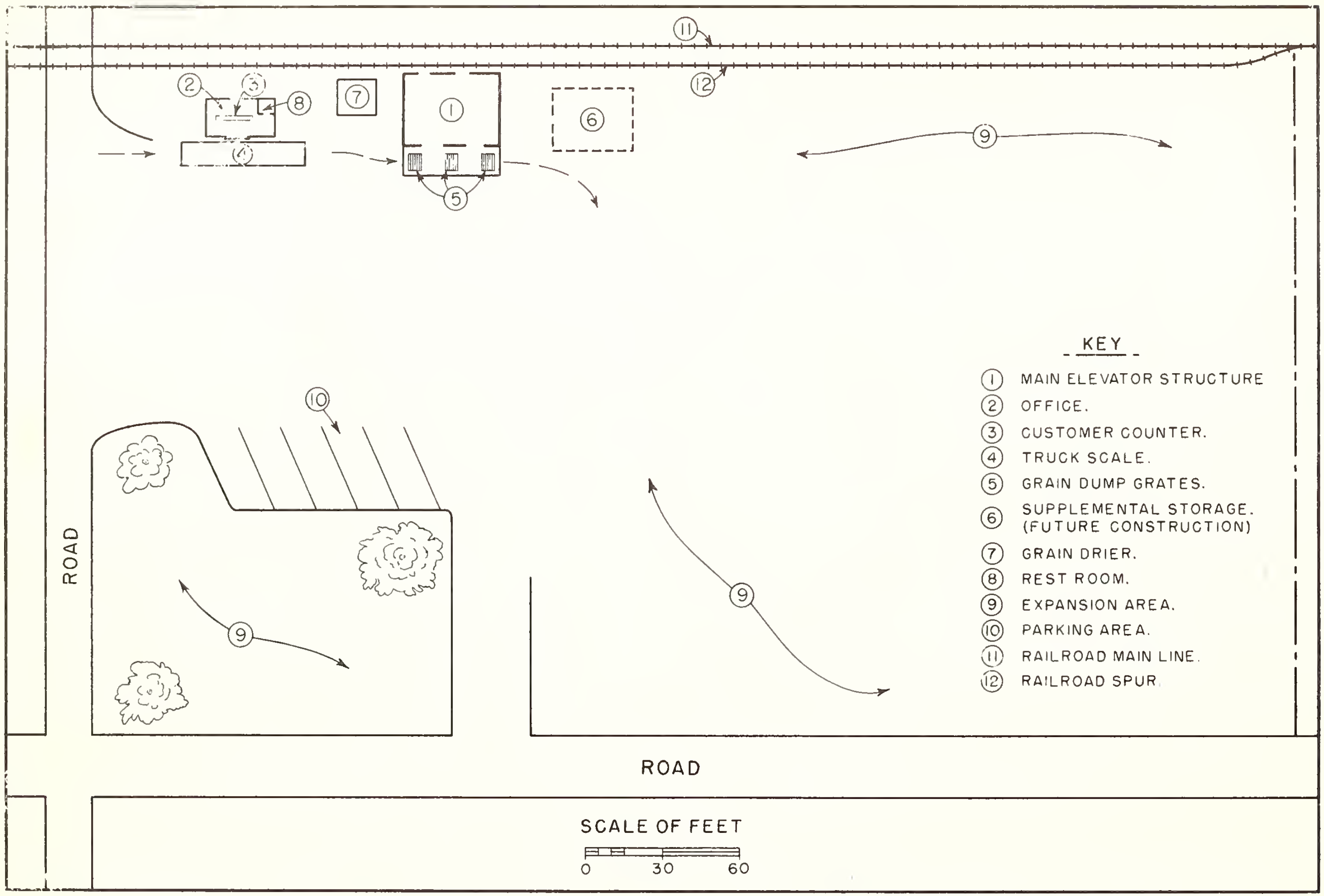

Figure 30.--Plot plan of a small country elevator for marketing grain only.

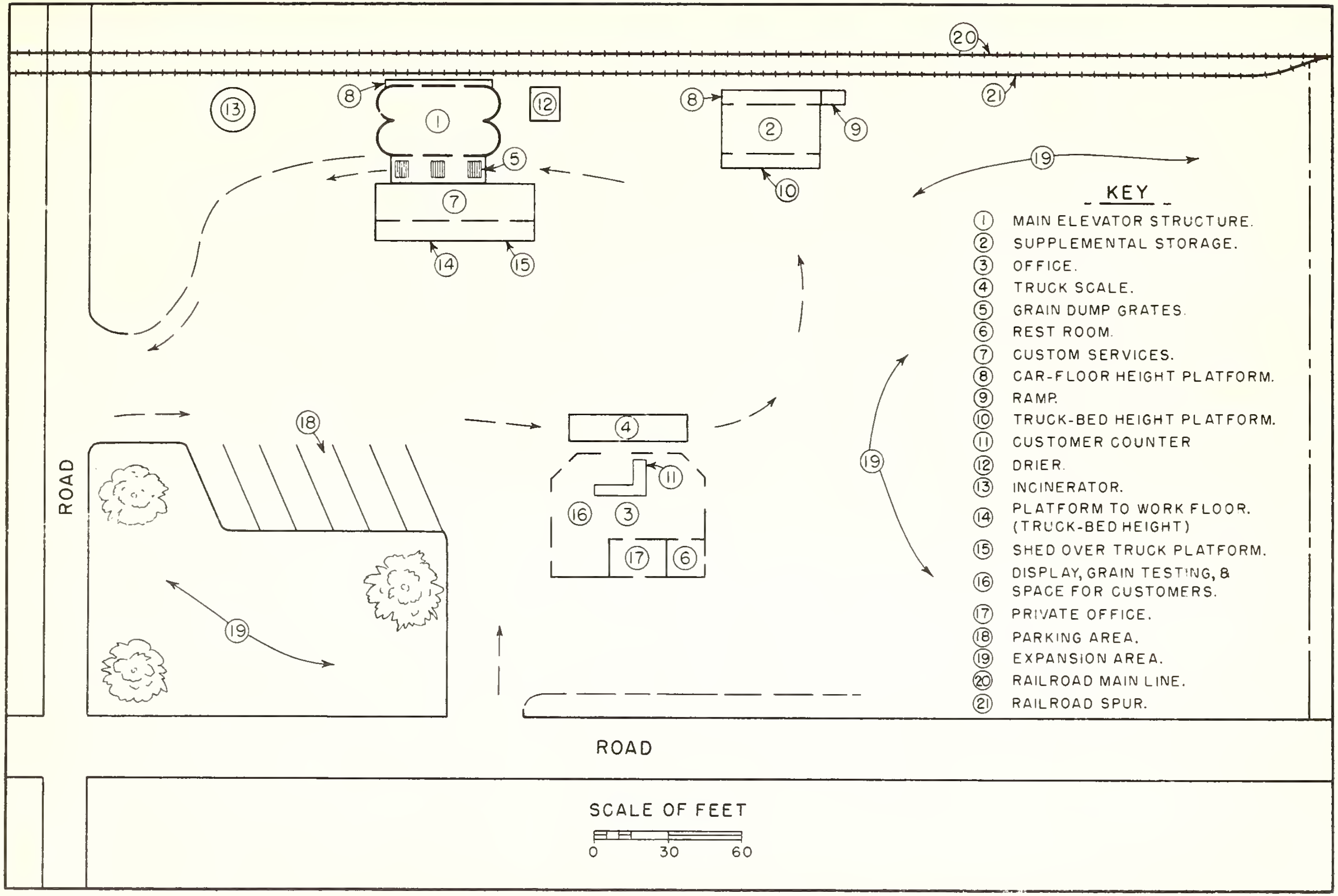

Figure 31.--Plot plan of a country elevator designed for marketing grain, performing custom services, and selling merchandise.

SOME PUBLICATIONS CONCERNING ELEVATOR FACILITIES AND OPERATION

The following publications may supply further information concerning elevator structures, facilities, and economic operations:

Business Policies of Country Grain Elevators --L. J. Norton. Bulletin No. 477, Agricultural Experiment Station, University of Illinois (1941), Urbana, Ill.

Business Analysis of Farmers' Grain Elevators-1947 --R. J. Mutti, L. F. Stice, L. J. Norton, and E. V. Stevenson. Department of Agricultural Economics, Extension Service, University of Illinois, Urbana, Ill.

An Economic Analysis of Local Grain Elevators in Indiana --A. F. Hinrichs. Bulletin 403. Agricultural Experiment Station, Purdue University (1935), Lafayette, Ind.

Farmers' Elevators of Ohio; Fifteen years, 1928 to 1943 --B. A. Wallace and J. I. Falconer. Bulletin No. 650, 1944. Ohio Agricultural Experiment Station, Wooster, Ohio.

Economic Aspects of Ohio Farmers' Elevators --L. C. Foster, Ohio Agricultural Experiment Station (1927), Wooster, Ohio.

Some Factors Affecting the Movement of Ohio Wheat --F. L. Foster, Ohio Experiment Station (1930), Wooster, Ohio.

Business Stability of Iowa Farmers' Elevators --E. B. Ballow. Bulletin No. 44. U. S. Department of Agriculture (1941), Washington, D. C.

Farmers Cooperative Feed Mills, Plans and Operations (1948) --W. M. Hurst. Miscellaneous Report 125. U. S. Department of Agriculture, Washington, D. C.

Storage; 1950 --Farmers Grain Dealers' Assn. of Iowa, 1101 Walnut St., Des Moines, Iowa.

Handbook of Official Grain Standards of the United States --Revised 1949. U. S. Department of Agriculture, Washington, D. C.

A Financial and Business Analysis of Indiana Grain Elevators-- Station Bulletin 547 - 1950. Purdue University, Agricultural Experiment Station, Lafayette, Ind.

Drying Methods for Conditioning CCC Grain --G. H. Foster, Purdue University, Lafayette, Ind.

Storing and Drying Grain (1949) --L. E. Kirk, Lee Ling and T. A. Oxley. Food and Agriculture Organization of the United Nations, Washington, D. C.

Financial Results of the Operations of Illinois Farmers' Elevators in 1929-30 --L. J. Norton. Illinois Experiment Station, Urbana, Ill.

Progress Report - Engineering - A Preliminary Report on Corn Drying-- F. D. Young. Released 1946. Nebraska Experiment Station, University of Nebraska, Lincoln, Nebr.

Grain Elevators of North America --5th Edition --Clark. 1942 Published by Grain and Feed Journals, Chicago, Ill.

The Grain Storage Situation in Michigan --G. W. Motts. 1947 Michigan State College, Agricultural Experiment Station Cooperating with Grain Storage Study Committee, Michigan Department of Agriculture, East Lansing, Mich.

Marketing Margins and Costs for Grains, Grain Products, and Dry Edible Beans --Donald R. Stokes. Technical Bulletin No. 934. 1947 U. S. Department of Agriculture, Washington, D. C.

Where and How Much Cash Grain Storage for Oklahoma Farmers --Thomas E. Hall, Adlowe L. Larson, Howard S. Whitney and Charles H. Meyer. Bulletin 58. 1950. U. S. Department of Agriculture, Washington, D. C.

Where and How Much Cash Grain Storage for North Dakota Farmers-- Thomas E. Hall, Perry V. Hempill, Charles H. Meyer and Walter K. Dairs. Bulletin No. 61, 1951. U. S. Department of Agriculture, Washington, D. C.

Grain Production and Marketing (1949) --G. A. Collier. Miscellaneous Publication 692. U. S. Department of Agriculture, Washington, D. C.

Stored Grain Pests, Farmers' Bulletin 1260, 55 pp., (revised 1940)-- E. A. Beck and R. T. Cotton. U. S. Department of Agriculture, Washington, D. C.

Cleaning Grain on Farms and in Country Elevators --R. H. Black and E. G. Boerner. USDA Farmers' Bulletin 1542, 1927. U. S. Department of Agriculture, Washington, D. C.

Observations on Mold Development and on Deterioration in Stored Yellow Dent Shelled Corn --G. Semeniuk, C. M. Nagel and J. C. Gilman. Res. Bulletin 349, 1947. Iowa Agricultural Experiment Station, Ames, Iowa.

Rat Proofing Buildings and Premises --J. Silver, W. E. Crouch and M. C. Betts. U. S. Dept. Int. Conserv. Bulletin 19, 1942.

Protection of Buildings and Farm Property from Lightning --Farmers' Bulletin No. 1512. U. S. Department of Agriculture, Washington, D. C.

Planning Grain Elevators in the Southeast --W. M. Bruce, W. E. Garner, J. W. Simons and L. L. Smith. 1951. University of Georgia, College Experiment Station, Athens, Ga.

Storage of Small Grains and Shelled Corn on the Farm, 1949, --C. K. Shedd and R. T. Cotton. Farmers' Bulletin 2009. U. S. Department of Agriculture, Washington, D. C.

Control of Insect Pests of Grain in Elevator Storages --Farmers' Bulletin No. 1880, U. S. Department of Agriculture, Washington, D. C.

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