TESTING AND DEVELOPING OF AN EFFICIENT FORAGE PLOT THRESHER

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INTRODUCTION

There is no subject which lies closer to the welfare of the human race, with its population of nineteen hundred million, than the production and maintenance of the necessary food supply. The actual growing of a crop is but a small portion of the over-all agricultural problem; and conditioning, processing, selling, and many other phases of agriculture must play their part in bringing the commodity to the public.

In the development and progress of the nations agriculture, soil-building crops and vegetation are of the utmost importance in maintaining and improving our food supply. State agricultural experiment stations, Federal experiment stations, and private industries are striving to maintain a high agricultural production and develop new and superior crops for the nation. Research work is conducted in each State of the Union, and millions of dollars are spent annually in developing a "new" agriculture. This research is a gamble, and must be lavish of ideas, money, and time. Some years progress is rapid while other years useful results are slow in development.

Along with the increase in population and the demand for more and better crops, the need for an intensive research program is apparent. At the present time, increase in crop testing, expansion of plant breeding, and development of newer crops are demanded of the state and Federal experiment stations, as well as private industry. Because agriculture is thus progressing, research work in testing and developing crops must also progress. One phase of this research work is the development of small, efficient plot threshers to harvest the tested crops.

Experimental plot threshers are not new. Methods of experimental crop harvesting date back to the inception of state experiment stations in 1887. Since this date, developments have advanced with crops and adaptations of crops. One of the principle problems confronting the cereal or legume breeder is efficient threshing of experimental crops. This is especially true in Oregon where crop production is so diversified and the need for experimental threshers is acute.

The increase in experimental land has not been comparable to the diversification and increase in crop production. Therefore, the individual experimental plots are reduced in size each year to allow for this expansion. This means the samples taken for threshing will be smaller and the changes in the experimental threshers must be altered accordingly. The development of an efficient forage plot thresher was accomplished by the Agricultural Engineering Department at Oregon State College, Corvallis, Oregon, and is discussed in this text.

PURPOSE OF TESTING AND DEVELOPING

The need for an efficient forage plot thresher to handle cereal and legume crops for the state experiment stations is acute. The experimental threshers used in the past have not been suitable for our changing agriculture. Plans were made to develop or purchase a thresher which would be suitable for handling the small plots of experimental test material. Parties interested in obtaining such a thresher were H. H. White, Associate Agronomist of the Southern Oregon Branch Experiment Station, Medford, Oregon; Malcolm Johnson, Project leader of the Deschutes Experimental Area, Redmond, Oregon; and D. D. Hill, Agronomist in charge of Farm Crops Department, Oregon State College, Corvallis, Oregon. Each agency contributed toward obtaining a satisfactory forage plot thresher. The author, working under the direction of the Agricultural Experiment Station, Oregon State College, Corvallis, Oregon, developed an efficient forage plot thresher. Mr. Hill later relinquished his portion of the project to the other two members.

Purchase Of The Turner Two-wheel Thresher

The Turner Two-wheel Economy Thresher, manufactured by the Turner Manufacturing Company of Statesville, North Carolina, was purchased for this project. This portable thresher was developed by the Tennessee Valley Authority in co-operation with state agricultural experiment stations and extension services. It was specially designed to help farmers grow more soil-building crops on small farms in areas where fields are hilly and sloping. The Turner thresher is easily towed up to 50 miles per hour by automobile or truck on paved roads. It follows the towing vehicle satisfactorily. Once in the field, the thresher can be set up ready for threshing in from five to fifteen minutes. For sidewise leveling, there are only two wheels to block; for lengthwise leveling, only one adjustment is needed on the front support.

Type of Test Plots

A gradual change from large area test plots to plots of smaller size has been evident in the past ten years. In the large test plots, the chance for error is held at a minimum because a large quantity of seed is threshed; whereas, errors are magnified in small test plots. Extensive plant breeding is in demand today. Also the demand for varietal development among species has increased, requiring more research work each year.

At the present time, the area of test plots is small and varies with the amount of available land and crops to be tested. For example, clover samples may be grown on test plots being a rod in length and 39 inches in width; or a plot measuring 10 by 20 feet will be used to secure three yard square samples. In threshing material from these small plots, inaccurate results may occur. It is important, therefore, to collect all seed in order to obtain accurate results when pro-rated on an acre basis. With the increased use of statistics, many replications of each test must be made in order to present significant results. Thus, it is imperative that strict control of possible errors, due to small plot testing, be held to a minimum.

Future test plots, from all indications, will be equal in size or smaller than those used today. An increase in plant breeding of all crops is anticipated as well as the development of new strains of plants and improvement of the present varieties.

Type of Crops The Thresher Was to Handle

The Turner Two-wheel Thresher was purchased for threshing rod square plots. It was thought that the thresher could easily and efficiently handle the material from plots of this size since the capacity of the machine was limited. However, reconsideration of previous plans reduced the size of the test plots from rod square to yard square on Ladino clover, and from shocks to bundles on grains. Clover samples were taken from plots of either yard square or rod length by 39 inches in width. This produced a very small sample for threshing and resulted in poor cylinder threshing efficiency.

Reason For Test Work

In order that the Turner Two-wheel Thresher could be made suitable for test plot threshing, a number of changes were made in its construction. Results of tests conducted determined further changes and machine improvements. Rapid clean out of the machine and equal threshing of all samples had to be developed. It was toward this goal that test work was performed and machine improvements made.

Reason For Development

The state agricultural experiment station was in need of a thresher that could easily be transported from one branch experimental station to another, and one that could effectively handle both clover and grain crops. All work on the Turner Two-wheel Thresher was directed toward developing a desirable machine to efficiently thresh forage plot samples.

PREVIOUS WORK ACCOMPLISHED

Experiment stations throughout the country have been confronted with the problem of developing small forage plot threshers suitable for their crops. Each crop reacts differently to threshing techniques, and in most cases a different thresher or modification of one must be used on different crops. Not only do different crops require varied threshing techniques, but also threshing procedure is altered by varieties within a crop, weather conditions at the time of growth and harvest, soil conditions under which the crop is grown, and individual differences at each experiment station. A small plot thresher applicable to Oregon conditions, for instance, may be useless in Utah or Arizona. Experimental threshing is so individual that use of commercial threshers is not applicable, and design and construction of plot threshers is necessary in most cases.

Utah Experimental Thresher:

A specially designed, small thresher has been successfully developed and used for the vegetable seed production studies being conducted jointly by the U. S. Department of Agriculture and the Utah Agricultural Experiment Station (1, pp. 28-29). According to Leslie R. Hawthorn, the designer of this thresher, it does a remarkable job of threshing vegetable seed crops. The principle feature of the machine is a complete cylinder assembly of the Allis-Chalmers All Crop Harvester, Model 40. The assembly is complete in that all essential elements have been incorporated, but the length of the cylinder has been reduced from 42 inches to 20 inches. As the material being threshed leaves the thresher, it passes through a chute and falls on the single separating screen. The screen scalps off most of the chaff. The seed, together with the smaller sticks and broken leaves, falls through the screen to a rectangular receiving box. This thresher can be easily operated by one man and is quickly cleaned out between samples.

Deawning Threshed Grass Seed With A Hammer-Mill

At the nursery division, Soil Conservation Service, Pullman, Washington, considerable work has been accomplished in removing the awns from bluebunch wheatgrass, blue wild-rye, Canada wild-rye, tall oatgrass, bulbous barley, and other seeds in which the awns are extremely tenacious. Processing was done by removing the awns in a hammer-mill (3, pp. 14-15). According to John L. Schwendiman, Assistant Agronomist in charge of this work, seed tested was successfully deawned with the speed of the hammer-mill cylinder being between 600 and 1200 rpm depending on the species of seed. The correct size of mill screen used and the mill fed at the full rate are necessary for efficient deawning with a hammer-mill. Swinging and solid type hammer-mills were used in this test and both proved equally effective at the optimum speed for each machine.

Deawning of seed greatly reduces its bulk, and facilitates both handling and storage. In planting deawned seed, little trouble is experienced in the drilling operation, whereas, seeds with their awns intact cause considerable trouble in the drill when planting.

Threshing Stipa Grass Seed

The State of California has a problem in threshing Stipa grass seed. Methods of harvesting this seed have been developed jointly by the Agronomy and Agricultural Engineering Departments at Davis, California. Mr. Sumner of the Agronomy Department, and R. A. Kepner, Agricultural Engineering Department, developed a pusher type machine to harvest the Stipa seed which is planted in rows at the experimental farm at Davis, California. The Stipa grass seed ripens quickly and shatters readily. This machine, according to Mr. Kepner, does a better job than commercial machines and allows direct combining rather than using a binder and then threshing. Higher germination of the seed is obtained by allowing the seed to mature in the field rather than binding in the greener stage. This pusher-type machine, mounted on a small tractor, enables lifters to float between rows with V-belts traveling backward giving the Stipa grass straws a slight rearward movement with relation to the ground. Large beaters knock the seed into a pan which is under and slightly behind the beater reel.

Clover Threshing At Madras, Oregon:

In the Madras Irrigation Project, there are 50,000 acres under irrigation. Twenty thousand acres of this land are in Ladino clover, 4,000 acres are in red clover, and approximately 800 acres in Alsike clover. The clover threshing operation in this area is not experimental, yet, it is necessary to mention some of the project's operations to give an over-all picture of clover threshing. In commercial threshing of clover, many harvesting methods are employed, and one farm operator's method may be entirely different from his neighbors'. There is no set procedure for harvesting and individual differences of the farm operators play a large part in determining a method of harvest. Then, too, soil conditions vary the growth characteristics of clover so much that one stand of clover may have to be handled differently than another stand.

Here in Oregon, commercial methods utilized in threshing of clover are numerous. A few of these methods are as follows: (a) combine from the stand; (b) combine from the windrow; (c) combine from the swath; (d) cured in windrow, picked up and stored for later threshing; (e) cured in cocks and threshed in the field, or stored for future threshing; (f) cut green and stacked, using artificial method of curing. In Eastern Oregon, most farmers prefer (a), (b), (c), and (f); and in Western Oregon, the farmers prefer (a), (b), (c), and some (e).

Experimental threshing often parallels commercial threshing in problems such as those mentioned above. It is, therefore, difficult to perfect an experimental thresher which is applicable to a crop grown in various parts of the state. Then, too, an experimental thresher developed for one experiment station and its various crops may be ineffective for threshing crops on another experiment station. Cereal and legume breeders must cope with problems such as this, and often rely upon their intuition in perfecting methods for harvesting experimental crops.

METHODS AND PROCEDURE

Several modifications of thresher construction were necessary to convert the Turner thresher into an experimental plot thresher. This work was accomplished during the summer of 1949, and throughout the year of 1950. Some test work extended into January, 1951, but most of the mechanical changes and tests were performed in 1950. This phase of the work was divided into three parts. They were as follows: Shop methods and procedure, field methods and procedure, and laboratory methods and procedure.

SHOP METHODS AND PROCEDURE

All shop work was accomplished in the Agricultural Engineering Department at Oregon State College. Changes were made from information obtained from test runs on threshed material, ideas taken from commercial machines, and information received from men skilled in the operation of threshing.

Construction of Machine

The specifications for the Turner Two-wheel Economy Thresher as advertised by the Turner Manufacturing Company are as follows:

Frame-body

Unusually strong frame constructed of hot riveted channel and angle iron. Sides and deck are made of galvanized sheet steel, and securely riveted to the frame.

Trucks

Furnished are either two 26 inch steel wheels or two standard tread, deep, drop center, roller bearing wheels for 600 by 16 tires. Alemite grease fittings supply lubrication to the roller bearings.

Cylinder

The free swinging, cold roll bars of the cylinder are durable, hammer-mill type, with six rows of bars 1/4 by 1 1/4 by 5 inches long. There are 40 or 41 bars per row or a total of 243 bars. The bars are equally spaced and placed on hard SAE 1045 steel shaft 1 7 /16 inch in diameter. The cylinder is 28 inches wide and 19 inches in diameter, and is carefully balanced and mounted on dust-proof roller bearings to run smoothly at all speeds. A special rice cylinder is available. This cylinder is comparable to the peg-toothed cylinders used on commercial combines and threshers.

Cylinder Speeds

Various speeds are easily obtained, depending upon the type of material being threshed, by changing the pulley combinations used on the countershaft and cylinder shaft. Cylinder speeds range from 320 to 1256 rpm.

Drive

The cylinder is driven by three V-belts on V-type pulleys with power supplied by either a 7 to 9 hp stationary gas engine, tractor power, or an electric motor. Standard equipment is either a 9 inch V-type pulley for gasoline engine power or 6 1/4 inch face by 7 1/2 inch diameter flat pulley for tractor power. The gasoline engine is mounted on the thresher platform.

Straw Rack

V-belts transmit positive power to one eccentric on each side of the straw rack for smooth, gradual discharging of straw to the rear exit. Grain drops down upon a galvanized sheet steel pan integrally constructed with the rack. Seed moves from this pan to the return pan and then onto the cleaning sieves.

Cleaning

Three sieves or screens, with an air blast from a fan, clean seed thoroughly. Depending upon the crop these sieves and the fan can be adjusted for cleaning.

Dimensions

Uncrated and assembled for use, the length of the Turner thresher is 12 feet, height 6 feet, width of inside frame 30 inches, and the weight, without engine, is 1400 pounds.

The specifications above are listed by the manufacturer and cover only the main essentials of the thresher. Changes and modifications in the thresher, which were necessary to convert it to an efficient forage plot thresher, will be described under Modifications of Machine.

Modification of Machine

Discussion of changes and modifications necessary for development of an efficient forage plot thresher will follow:

Strengthening Framework

The frame of the thresher was constructed of light angle and strap iron secured in place by hot riveting. This type of construction was not satisfactory, and it was found necessary to strengthen the frame by welding additional angle and strap iron braces to it. The riveted joints of the thresher were also welded as a further means of strengthening the frame.

Sheet Metal Feeding Pan

The feeding trough is detachable from the framework of the thresher. When in place, there was a large gap at the junction of the concaves and feeding trough. Loss of seed was excessive at this point requiring the construction of a feeding pan which would cover this gap, and attach to the concaves in such a manner that no seed would be lost in the feeding operation. Constructed of 26 gauge sheet steel, the sides of the feeding pan extend up and over the side of the feeding trough and are secured to the trough by means of wood screws. At the junction, the pan is flush with the sheet metal framework. The connection of the feeding pan to the concave was accomplished by extending the metal under the first rub plate of the concave. Metal screws held the plate and the lip of the pan tight against the concave surface. Refer to Plate No. 1 in Exhibits for further information.

Concave

Ladino clover seed will pass with ease through a 5/64 inch hole; therefore, tight construction of the machine is necessary to retain all threshed seed. A wide gap existed where the concave sides met the sheet metal frame of the thresher. This gap was eliminated by cementing strips of 5/16 inch sponge rubber to the right and left concave sides.

Attached to the concave unit is a perforated, galvanized grate-deflector which allows most of the threshed seed to pass through the grate openings to the return pan and the straw to be deflected up and onto the straw rack. This galvanized deflector was brazed to the concave plate so that no seed would lodge in the crack at the junction of these two units. Where the deflector touched the sheet metal housing of the thresher, Smooth-on metal cement was applied to fill all gaps and crevices.

Motor Mount and Tightener

Power was supplied to the cylinder shaft from a 6.8 to 9.2 hp, single cylinder "Wisconsin" A.H.H. air-cooled engine, mounted on the right-hand side of the engine platform. In 1949, test work was conducted with the engine bolted directly to the platform. This was later changed to afford a simple adjustment of drive belt tension and a more substantial base for the engine. For this reason, a motor mount was constructed of 5/16 inch steel plate with a quick screw adjustment for rapid tightening. This tightener consists of a bolt screwed against the end of the motor mount in such a manner that the motor moves toward or away from the thresher cylinder, thus loosening or tightening the drive belts as desired. Refer to Plate No. 3 and 4 for further information on the motor mount and tightener.

Compressor Mount and Tightener

A compressor was installed on the platform directly in back of the motor to supply air under pressure for cleaning out the thresher. A V-belt drive from the power take-off of the motor operated the compressor. A five gallon oxygen bottle served as a compressed air tank. The pressure relief valve was set at 105 psi. The compressor mount and its operation is shown on Plate No. 5.

The tightener, joined to the compressor mount, is quick and easy to manipulate. With the throw arm in a vertical position, the tightener eliminates tension from the V-belt transmitting motor power to the compressor. When the arm is moved to the left, the compressor belt is pulled taut which puts tension on the V-belt. The tightener arm is secured in place by a stationary metal strip recessed for adjustment of tension on the belt. With the motor operating at 1200 rpm, a pressure of 105 psi can be obtained in the compressed air tank in five minutes. The compressor mount and tightener is shown on Plate No. 5.

Compressor Belt Guard

Protection for the operator is provided by means of a sheet steel guard over the compressor belt. This guard is secured to the motor with a 1/4 inch by 1/2 inch metal screw, and to the platform with 1 1/4 inch, No. 10 wood screws. The compressor belt guard is shown on Plate No. 7.

Compressor Belt Guide

A guide was constructed to hold the compressor belt in place ready for instant use. The construction of this compressor belt guide is shown on Plate No. 6.

Air Deflectors

Control of the amount of air to the cleaning sieves is important for efficient forage plot threshing. The problem of controlling this air existed with the Turner thresher, and air deflectors were installed in the air passage leading from the fan housing to the cleaning screens. The Turner thresher was originally equipped with adjustable openings on either side of the fan housing to control the quantity of air required for seed cleaning. Leakage of air and direction of air flow from the fan housing was unsatisfactory for chaffing clover seed. It was not economically feasible to install adjustable V-pulleys to maintain proper fan speed for correct velocity of air required for cleaning clover seed. Therefore, two adjustable 1/4 inch plywood plates were installed in the air stream passage which projected from the fan housing. This allows complete control of air by individual adjustment of the plates. The construction of the air deflectors is shown on Plate No. 9.

Compressor Tank Mount

The compressed air tank was mounted upon a 5/8 inch plywood frame located behind the compressor. This frame was secured to the platform with 1/4 by 1 inch lag bolts. The compressor tank mount is shown on Plate No. 8.

Straw Rack

The original straw rack was constructed of wood and sheet steel. Considerable lodging of seed and chaff occurred, and an attempt was made to repair this rack in

1949. All attempts failed, requiring the construction of a new straw rack suitable for efficient separation.

The new rack was constructed with 2 by 2 by 5/16 inch angle iron welded into a solid frame. The rack pan and discharge seed pan were riveted and soldered to this frame to form a tight, solid unit. Construction of the new rack did not allow sufficient slope of the rack pan to afford satisfactory separation. A reverse wind action occurred in the straw rack due to the tightness of construction. Also, a slow movement and bunching of the straw occurred as it moved toward the rear of the machine. The straw rack construction is shown on Plate Nos. 10 and 11.

Return Pan

Construction of a new return pan was necessary to effect a tight, easily cleaned unit. The old return pan was constructed of corrugated sheet steel butting against a wood frame. This caused lodging of seed and chaff when threshing Ladino and Alsike clover. An attempt to fill the cracks and crevices in the return pan with solder proved unsatisfactory in forming a suitable bond on both wood and sheet steel. A new return pan was constructed of 26 gauge sheet steel using a flat base with sloping sides. A steeper slope on the return pan was obtained by raising the front end 2 inches and extending the discharge end 6 inches over the sieves. This allowed the seed to drop onto the chaffing screen in such a manner as to utilize the chaffing air more efficiently. No cracks or crevices were left unsoldered. Thus, accumulation of seed or chaff was permitted. Plate No. 12 shows the construction of this return pan.

Shaker Seed Pan

Cleaned seed from the sieves dropped to a sheet steel pan similar to the original return pan. The slope of this pan and the corrugated surface did not allow threshed seed to move rapidly into the seed chute. A new shaker seed pan was constructed to effect rapid movement of seed. A greater slope was obtained on this seed pan by lowering and relocating the brace work on the thresher frame under the shaker seed pan. The new shaker seed pan was constructed with a flat bottom, and sloping back and sides similar to the new return pan. The sloping sides and back, along with an increase in the per cent of slope of the pan, greatly facilitated movement of threshed seed into the seed chute. The shaker seed pan was constructed with 22 gauge sheet steel and was secured to the sheet steel frame of the shaker unit by riveting and soldering. Construction of the shaker seed pan is listed on Plate No. 13.

Seed Chute

The original seed chute could not be utilized with the new shaker seed pan, and a new seed chute was constructed. This seed chute was designed to facilitate movement of seed to the seed bag or container collecting the seed. A sheet steel, hinged door at the discharge point of the seed chute holds threshed seed intact for easy removal, and prevents wind from disrupting cleaning operations. The seed chute is shown on Plate No. 14.

Finger Deflector and Canvas Checks

An adjustable finger deflector placed above and at the front of the straw rack retards the movement and deflects downward the threshed material coming from the cylinder. The threshed material then falls onto the front of the straw rack and moves rearward allowing proper separation of threshed seed from the straw. This finger deflector consists of 39, 3/16 inch round rods welded to a 1/2 inch steel pipe suspended from the top of the thresher frame. The 39 fingers were covered with gum rubber tubing to prevent cracking and scuffing of the seed.

Two canvas checks were installed above the straw rack. These checks direct the straw and seed downward onto the straw rack.

Balancing Bottom Shaker Unit

The new straw rack weighed 39 pounds more than the original straw rack. It was, therefore, necessary to balance the straw rack and the bottom shaker unit. This was accomplished by adding lengths of 5/8 inch by 6 inch strap iron to both sides of the bottom shaker frame. With an increase of 39 pounds on the straw rack, 139 1/2 pounds were required on the bottom shaker unit for proper balance. After bolting the counterweight to the bottom shaker unit frame, Smooth-on cement was applied to fill all cracks and crevices to prevent seed lodging.

Minor Modifications

Elimination of cracks and crevices in the seed passage was essential for efficient forage plot threshing. These minor modifications included riveting sheet steel frame work, application of Smooth-on metal cement, and small changes and improvements necessary for efficient threshing.

FIELD METHODS AND PROCEDURE

Granger Experiment Farm

Experimental threshing, conducted at Granger, Oregon, in 1949, consisted of sufficient test runs of oats, wheat, and barley to familiarize the author with the Turner thresher and the various methods and procedure required for threshing grain.

Southern Oregon Branch Experiment Station

Two hundred, yard square samples of Ladino clover were threshed in 1949 at the Southern Oregon Branch

Experiment Station, Medford, Oregon. A number of these clover samples were rerun to determine machine efficiency. From the seven samples rerun, the amount of seed obtained ranged from 4.4 to 8.6 per cent of the amount obtained from the first run of each sample.

Deschutes Experimental Area

Since Deschutes County produces most of Oregon's Ladino clover, most of the experimental test work on threshing was conducted at the Deschutes Experimental Area, Redmond, Oregon, where an ample supply of test material was available.

In 1949 and 1950, experimental samples of Ladino and Alsike clover, along with samples of wheat, oats, and barley, were threshed at Redmond. Work conducted on these crops played a major part in supplying information and data necessary for the modification and reconstruction of an efficient forage plot thresher.

LABORATORY METHODS AND PROCEDURE

In experimental threshing, it is important that all samples of a test be equally threshed. This is not possible unless the moisture content of all samples in the test remains constant throughout the threshing process. Tests on the moisture equilibrium, and the effect of moisture on the threshability of Ladino clover were conducted at the Agricultural Experiment Station, Oregon

State College, Corvallis, Oregon. Threshability may be defined as the relationship between the threshing efficiency and the moisture content of the sample being tested. Threshing efficiency may be defined as the ratio of seed obtained to the total seed in a given run times 100. The method and procedure for accomplishing this work is as follows:

<u>Method of Drying Samples</u>

After conditioning, samples were subjected to a temperature of 205 degrees Fahrenheit in a Scientific Laboratories heat oven for 40 hours to determine the moisture content of the conditioned sample.

<u>Method of Cleaning and Weighing Samples</u>

The seed obtained from the threshing of conditioned samples was first cleaned with a Bates Aspirator to remove chaff and foreign matter, and then recleaned with a Dakota blower to separate fine chaff and lightweight material from the seed. Cleaned seed was then weighed with 1000 gram analytical balance.

<u>Method of Conditioning Samples</u>

To determine the proper conditioning procedure for Ladino clover, a moisture equilibrium curve was required. (See chart 1) These moisture equilibrium studies were patterned after basic research work accomplished by C. Ivan Branton, Fiber Flax Division, Bureau of Plant

Industries, Soils, and Agricultural Engineering, U.S.D.A., Corvallis, Oregon, and Frank J. Zink, Agricultural Engineering Department, Kansas State College, Manhattan, Kansas.

Mr. Branton's studies on moisture equilibrium of fiber flax were conducted at 80 and 140 degrees Fahrenheit. Mr. Zink's work on U.S. No. 1 red clover was conducted at 80 and 84 degrees Fahrenheit (4, pp. 451-452). Mr. Zink's studies on red clover were more applicable to work of moisture equilibrium on Ladino clover. (See Chart 2.)

Samples were prepared and placed in small aluminum baskets. Each basket was assigned to an airtight moisture can. The samples, in their respective basket with the moisture cans, were placed in the experimental fiber flax drier-conditioner, pictured in figure 28 in Exhibits, and the conditioner set to maintain a dry bulb temperature of 100 degrees Fahrenheit. The operator, by varying the intake of outside air, and the wet bulb temperature, maintained an atmosphere of desired relative humidity within the conditioner.

At the end of a six hour conditioning period, samples and moisture cans were removed from the conditioner. The sample in the basket was quickly placed in the moisture can, sealed, and weighed with the analytical balance.

Samples were then subjected for 40 hours, to 205 degrees Fahrenheit in a Scientific Laboratories heat oven. Samples were again weighed. This procedure was followed in bringing samples to their equilibrium moisture content at atmospheres of 24.5, 40, 50, 60, 70, and 80 per cent relative humidity. A moisture equilibrium curve was plotted from the data obtained in these tests. Correct conditioning procedure for samples to be threshed was determined from this moisture equilibrium curve.

Approximate yard square samples of Ladino clover were conditioned for six hours at 9.5, 20, 29, 39.5, 56, 68, 75, and 80.5 per cent relative humidity. (See table 13.) While the samples were being conditioned, some of the air from the conditioning chamber of the drier was by-passed into a 29 gallon can. Small strips of rubber cemented to the underneath side of the lid effected an airtight can. After conditioning, samples were placed in the airtight can which held the sample at the same condition as that of the drier. Threshing immediately followed conditioning. Precautionary measures were taken to thresh each sample equally and thus minimize threshing error.

Method of Analyzing Results

Threshed samples were cleaned and weighed as previously mentioned. Complete data was recorded and statistically analyzed by Dr. J. C. R. Li, Biometrician for the Agricultural Experiment Station.

Apparatus Used

The apparatus used for determining the moisture equilibrium and the effect of moisture on the threshability of Ladino clover was as follows:

1. Experimental Fiber Flax Drier-Conditioner. (See figure 28 in Exhibits. Letters on the print correspond to the following list.)

   a. Manual static pressure regulating valve.

   b. Valve to permit measurement of fresh air added to system.

   c. Cut-off valve.

   d. Operating mechanism for air intake and exhaust valve.

   e. Steelyard weight beam. (not used in this experiment.)

   f. Air meter. (Not used in this experiment.)

   g. Bristol temperature recorder for dry bulb.

   h. Watthour meter. (Not used in this experiment.)

   i. Bristol, two bulb temperature recorder and controller for wet bulb.

   j. Panel of switches for heat control.

   k. Power switch.

l. Drier chamber.

m. Suspended drying kiln.

n. Drier chamber door.

o. Electric heater unit.

p. Intake valve.

q. Distilled water reservoir for wet bulb thermocouple.

2. "Brown Electronik" Potentiometer Pyrometer with thermocouples. (See figure 29.)

3. "Braun Krecht-Heimann" analytical balance. (See figure 30.)

4. "Scientific Supplies Co." electric heat oven. (See figure 30.)

5. Squeeze-top moisture cans, size 2 1/2. (See figure 30.)

6. Aluminum sample baskets. (See figure 30.)

7. Twenty nine gallon, airtight can.

8. "Bates aspirator.

9. "Dakota" blower.

10. Experimental thresher.

RESULTS

Numerous tests were conducted in developing this forage plot thresher. Information obtained from these tests was used to develop and improve this machine. After the thresher had been developed satisfactorily, several final tests were conducted to secure information for future test plot threshing. This test data is recorded in Tables 1 to 13 inclusive and is included in this report. Results of these tests are as follows:

Table 1 -- Per Cent of Seed Loss Due to Threshing

In almost all threshers, whether experimental or commercial, some seed is lost in the threshing procedure. Loss of seed may occur in the chaffing operation or when feeding material into the machine. The amount of seed lost from a threshed sample was determined by collecting threshed material from the seed spout and, at the same time, collecting the seed that had been lost around the machine. After each test run, seed from the spout and seed picked up around the machine were weighed to determine the per cent of seed loss.

Results show that the loss in seed was 1.032 per cent for wheat, 0.724 per cent for barley, and 0.394 per cent in oats.

Table 2 -- Forage Plot Thresher Adjustments

Adjustment of the machine can easily be made to handle various crops. A table of adjustments was compiled so that the operator could rapidly adjust the thresher to handle various crops. These adjustments include the cylinder, concave, fan, air deflectors, all sieves and screens, and the tail deflector. It should be noted, however, that the adjustments listed on table 2, are a guide to the operator and the final adjustments are determined by the individual crop.

Table 3 -- Forage Plot Thresher Adjustments, Belts and Pulleys

In experimental threshing, a change from one crop to another, such as Ladino clover to oats or oats to wheat, requires a change in pulleys and belts to maintain the correct ration of speed between cylinder and straw rack. The straw rack, for efficient operation, should operate at 240-260 rpm. Different crops require different cylinder speeds to effect satisfactory threshing efficiency and minimize mechanical injury to the seed.

L. G. Jones, et al of California, have made tests on alfalfa with 16 different combines operating at various cylinder speeds (2, pp. 8-16). The results of these tests demonstrate that the amount of seed damage is closely related to the peripheral speed of the cylinder. It was also found that after proper adjustments had been made on these 16 combines, the best peripheral speed for machines not equipped with flax rolls appeared to be between

4,500 and 5,000 feet per minute when threshing from the windrow. Table 3 lists the correct size pulleys and belts needed to maintain proper threshing efficiency on the crops tested.

Table 4 -- Effect of Cylinder Speed on Threshing Efficiency for Ladino Clover at 11.6 Per Cent Moisture Content

Ladino clover is difficult to thresh because the seed is held tightly in individual florets of the clover head. High cylinder speed must be maintained to enable separation of seed from the floret. Test results (as shown in Table 4) indicate that more seed was obtained on the first run with a cylinder speed of 1300 rpm. Cylinder speeds below 1300 rpm show a marked reduction of seed obtained on the first run.

Table 5 -- Threshing Efficiency of Experimental Forage Plot Thresher Developed at Oregon State College, Alsike Clover

Tests conducted by M. Johnson, Project Leader of the Deschutes Experimental Area, Redmond, Oregon, and statistically analyzed by Dr. J. C. R. Li, biometrician, indicate that the first of three threshings are as good an indication of yield as the total yield. Test analysis can, therefore, be based upon the amount of seed obtained on the first run. Table 5 also indicates that after three test runs of one sample, the amount of seed recovered from the chaff is less than 0.5 per cent of the total seed.

Table 6 -- Threshing Efficiency of Experimental Forage Plot Thresher Developed at Oregon State College, Ladino Clover

Data in Table 6, statistically analyzed by Dr. Li, also indicates that the first of three threshings are as good an indication of yield as the total yield. It is also shown in table 5 and 6 that Alsike clover is easier to thresh than is Ladino clover. Mr. Johnson found that some shattering of seed occurs in the field on the Alsike clover while no shattering was noted with Ladino clover.

Table 7, 8, 9, 10, 11, and 12 -- Moisture Equilibrium Studies, Ladino Clover

The equal threshing of experimental samples presents a problem to legume breeders. Test work to determine the effect of moisture on the threshability of Ladino clover is shown in table 13. A moisture equilibrium curve on Ladino clover was needed to accomplish this test. Tables 7, 8, 9, 10, 11, and 12 indicate tests which determine this curve and form the foundation for determining the threshability of Ladino clover. Results show, as listed on Chart 2 in Exhibits, that Ladino clover held for six hours in an atmosphere of 100 degrees Fahrenheit dry bulb and a relative humidity of 80 per cent effects a moisture content (dry basis) of 17.68 per cent. Conditioning with a dry bulb of 100 degrees Fahrenheit and a relative humidity of 24.5 per cent results in a moisture content (dry basis) of 8.46 per cent.

Table 13 -- Threshability Test of Conditioned Ladino Clover at 100 Degrees Fahrenheit

The threshability test was conducted upon completion of the moisture equilibrium studies. Data recorded is listed in Table 13 of this report. This study was statistically analyzed by Dr. Li.

Results of this test show that out of three runs, a sample conditioned to 18 per cent moisture content will thresh out approximately 51 per cent on the first run, but as the moisture content of the clover decreases to 6 per cent, approximately 80 per cent seed is obtained on the first of three runs.

Results also indicate that as the moisture content of the samples increases the seed obtained on the first run will be low, whereas, the subsequent runs will be high. (Refer to Table 13.) Also this test shows that the amount of seed obtained from the first run at 6 per cent moisture content is greater than the total taken for three runs of one sample conditioned to 18 per cent moisture content. (Refer to Chart 3 in Exhibits for the threshability curve.)

8-25-50 D. R. Long

Table 1

Per cent of Seed Loss Due to Threshing

All Weights in Grams

	Can No.	Tare Weight	Weight of can plus Material	Weight of Material	Percent loss in threshing	Average percent loss in threshing
Wheat						
Run 1-A	104	149.450	468.040	318.590		
1-B	123	151.550	154.570	3.020	0.943	
2-A	149	155.980	500.870	344.890		
2-B	148	150.420	154.530	4.110	1.190	
3-A	154	150.270	488.650	338.380		
3-B	163	151.600	154.900	3.300	0.975	
						1.032
Barley						
Run 1-A	141	150.380	668.670	518.290		
1-B	161	149.030	152.050	3.020	0.583	
2-A	167	153.580	674.920	521.340		
2-B	155	151.720	156.230	4.510	0.865	
						0.724
Oats						
Run 1-A	159	149.220	478.720	329.500		
1-B	171	151.690	152.980	1.290	0.392	
2-A	179	152.300	448.290	295.990		
2-B	168	152.130	153.300	1.170	0.396	0.394

Note: "A" runs designate seed obtained from the machine.

"B" runs designate seed picked up around the machine.

8-8-50 D. R. Long

Table 2

Forage Plot Thresher Adjustments

Type Crop	Cylinder Speed RPM	Concave Spacing Inches	Fan Housing #	Air Deflectors Top #	Air Deflectors Bottom #	Top Adj. #	Top Sieve Angle Back #	Top Sieve Angle Front #	Grain Screen Back #	Grain Screen Front #	Tail Deflector inches up	Note
Ladino	1275 to 1300	1/16-5/32 1/4 spacer Rt. cam 1/8 spacer Lt. cam	7	0	$\frac{1}{4}$-$\frac{1}{2}$	4	11	11	2	5	3/4	Finger Grate full down. Adj. canvas so weights almost touch shaker.
Oats	675	9/32-17/32	4	5$\frac{1}{2}$	1$\frac{1}{2}$	5	10	9	5	2	Full up	Oats may be fed fast.
Barley	675	9/32-17/32	4	5$\frac{1}{2}$	1$\frac{1}{2}$	5	10	9	5	2	Full up	Feed slow.
Wheat	950	# 7 rachet	1	2$\frac{1}{2}$	1$\frac{1}{2}$	6	10	9	5	2	Full up	Feed very slow.

8-8-50 D. R. Long

Table 3

Forage Plot Thresher Adjustments
Belts and Pulleys

Crop	Engine Pulley dia.	Cylinder Pulley dia.	Belt Engine To cylinder Sect.-length	Fan Pulley dia.	Belt Fan To Shaker Sect.-length
Ladino	5.4	6.0	B-112	5	B-83
Oats	5.4	11.0	B-120	6.5	B-85
Barley	5.4	11.0	B-120	6.5	B-85
Wheat	5.4	6.0	B-112	6.5	B-85

8-22-49 D. R. Long

Table 4

Effect of Cylinder Speed on Threshing Efficiency for Ladino Clover at 11.6% Moisture Content

Sample No.	Cylinder Speed in RPM	Can No.	Tare Weight Grams	Weight Can and Material Grams	Weight Material Grams	Threshing Per cent of Total Seed
A-1 run	1100	120	153.150	189.290	36.140	54.5
Rerun	1100	121	151.000	187.050	30.050	45.5
B-1 run	1200	120	153.150	204.360	51.210	62.5
Rerun	1200	121	151.000	181.780	30.780	37.5
C-1 run	1300	127	149.270	222.100	72.830	93.7
Rerun	1300	128	150.570	155.450	4.880	6.3

12-1-50 M. Johnson

Table 5

Threshing Efficiency of Experimental Forage Plot
Thresher Developed at Oregon State College
Alsike Clover

Sample No.	Run 1	% of total seed	Run 2	% of total seed	Run 3	% of total seed	Recovery from Chaff	% of total seed	Total Seed from Plot
1	0.374	87.6	0.045	10.5	0.007	1.6	0.001	0.2	0.427
2	0.505	87.4	0.073	12.6					0.578
3	0.355	85.1	0.050	12.0	0.010	2.4	0.002	0.4	0.417
4	0.463	88.9	0.058	11.1					0.521
5	0.389	88.0	0.053	12.0					0.442
6	0.388	84.0	0.060	13.0	0.012	2.5	0.002	0.4	0.462
7	0.425	85.9	0.070	14.1					0.495
8	0.558	87.2	0.067	10.5	0.013	2.0	0.002	0.3	0.640
9	0.459	95.0	0.024	5.0					0.483
10	0.443	89.5	0.052	10.5					0.495
11	0.369	81.1	0.036	7.9	0.048	10.5	0.002	0.4	0.455

12-1-50 M. Johnson

Table 6

Threshing Efficiency of Experimental Forage Plot Thresher Developed at Oregon State College

Ladino Clover

Weight of Clean Seed Per Run in 0.001 of Pound

Sample No.	Run 1	% of Total Seed	Run 2	% of Total Seed	Run 3	% of Total Seed	Total Seed From Plot
1	0.205	70.7	0.065	22.4	0.020	6.9	0.290
2	0.220	75.9	0.070	14.1			0.290
3	0.217	77.5	0.063	22.5			0.280
4	0.155	72.1	0.060	17.9			0.215
5	0.272	80.7	0.065	19.3			0.337
6	0.235	72.3	0.090	27.7			0.325
7	0.190	74.5	0.065	25.5			0.225
8	0.170	65.1	0.091	34.9			0.261
9	0.205	77.4	0.060	22.6			0.265
10	0.181	71.8	0.053	21.0	0.018	7.1	0.252
11	0.260	76.2	0.062	18.2	0.019	5.6	0.341
12	0.160	72.1	0.045	20.3	0.017	7.7	0.222
13	0.221	69.7	0.072	22.7	0.024	7.6	0.317

12-15-50 D. R. Long

Table 7

Moisture Equilibrium Studies
Ladino Clover

Run No. 1
Samples conditioned to 40% RH (79° W.B., 100° F D.B.)

Can No.	Tare	Length of exposure in hours	Gross Weight After 40% R.H.	Net Wt. Straw After Exposure to 40% R.H.	Bone Dry Weight Observed	Weight Moisture	Percent Moisture Bone Dry Basis
171	180.435	6	191.715	11.280	10.135	1.145	10.15
176	179.710	6	191.910	12.200	10.935	1.265	10.37
155	179.615	6	188.610	8.995	8.060	.935	10.39
123	180.050	6	180.050	10.550	9.500	1.050	9.95
159	178.105	6	190.040	11.935	10.780	1.155	9.68
			Average	54.960		5.550	10.10

12-18-50 D. R. Long

Table 8

Moisture Equilibrium Studies
Ladino Clover

Run No. 2

Samples conditioned to 50% R.H. (83° W.B., 100° F D.B.)

Can No.	Tare	Length of exposure in hours	Gross Weight After 50% R.H.	Net Wt. Straw After Exposure to 50% R.H.	Bone Dry Weight Observed	Weight Moisture	Percent Moisture Bone Dry Basis
161	179.850	6	191.370	11.520	10.275	1.245	10.80
168	183.000	6	196.670	13.670	12.135	1.535	11.23
167	183.625	6	197.785	14.160	12.560	1.600	11.30
156	180.710	6	193.820	13.110	11.600	1.510	11.50
148	181.240	6	196.430	15.190	13.440	1.750	11.51
			Average	67.650		7.640	11.29

12-20-50 D. R. Long

Table 9

Moisture Equilibrium Studies
Ladino Clover

Run No. 3

Samples conditioned to 60% R.H. (87° W.B., 100° F D.B.)

Can No.	Tare	Length of exposure in hours	Gross Weight After 60% R.H.	Net Wt. Straw After Exposure to 60% R.H.	Bone Dry Weight Observed	Weight Moisture	Percent Moisture Bone Dry Basis
171	180.435	6	193.440	13.005	11.275	1.730	13.30
176	179.710	6	190.760	11.050	9.540	1.510	13.65
155	179.615	6	192.230	12.615	10.945	1.670	13.23
123	180.050	6	190.530	10.480	9.120	1.360	13.00
159	178.105	6	189.835	11.730	10.175	1.555	13.23
			Average	58.880		7.825	13.29

12-21-50 D. R. Long

Table 10

Moisture Equilibrium Studies
Ladino Clover

Run No. 4

Samples condition to 70% R.H. (90.5° W.B., 100°F D.B.)

Can No.	Tare	Length of exposure in hours	Gross Weight After 70% R.H.	Net Wt. Straw After Exposure to 70% R.H.	Bone Dry Weight Observed	Weight Moisture	Percent Moisture Bone Dry Basis
161	179.850	6	191.710	11.860	10.170	1.690	14.26
168	183.000	6	193.525	10.525	9.020	1.505	14.28
167	183.625	6	197.545	13.920	11.885	2.035	14.59
156	180.710	6	190.450	9.740	8.350	1.390	14.27
148	181.240	6	194.420	13.180	11.030	2.150	16.31*
			Average	46.045		6.620	14.38

* Omitted from average

12-22-50 D. R. Long

Table 11

Moisture Equilibrium Studies
Ladino Clover

Run No. 5

Samples conditioned to 80% R.H. (93.7° W.B., 100°F D.B.)

Can No.	Tare	Length of exposure in hours	Gross Weight After 80% R.H.	Net Wt. Straw After Exposure to 80% R.H.	Bone Dry Weight Observed	Weight Moisture	Percent Moisture Bone Dry Basis
171	180.435	6	193.325	12.890	10.615	2.275	17.63
176	179.710	6	192.710	13.000	10.715	2.285	17.58
155	179.615	6	195.370	15.755	13.110	2.645	16.80*
123	180.050	6	190.295	10.245	8.425	1.820	17.75
159	178.105	6	188.530	10.425	8.575	1.850	17.71
			Average	46.560		8.230	17.68

* Omitted from average.

1-24-51 D. R. Long

Table 12

Moisture Equilibrium Studies

Ladino Clover

Run No. 6

Samples conditioned to 24.5% R.H. (72° W.B., 100°F D.B.)

Can No.	Tare	Length of exposure in hours	Gross Weight After 24.5% R.H.	Net Wt. Straw After Exposure to 24.5% R.H.	Bone Dry Weight Observed	Weight Moisture	Percent Moisture Bone Dry Basis
148A	181.240	6	190.315	9.075	8.315	0.760	8.38
176I	179.710	6	188.270	8.560	7.835	0.725	8.46
159G	178.105	6	187.315	9.210	8.425	0.785	8.53
167F	183.625	6	196.220	12.595	11.595	1.000	7.95*
1710	180.435	6	188.765	8.330	7.620	0.710	8.53
			Average	35.175		2.975	8.46

* Omitted from Average

2-2-51 D. R. Long

Table 13

Threshability test of Ladino Clover
Dry Bulb Temperature-100 degrees Fahrenheit

Sample	Wet Bulb Degrees	Run #1 Wt. Grams	Run #1 %	Run #2 Wt. Grams	Run #2 %	Run #3 Wt. Grams	Run #3 %
6-A	63.0	16.790	82.0	2.900	14.3	0.735	3.7
8-A	69.0	11.740	78.0	2.695	17.9	0.630	4.1
9-A	74.0	18.885	78.5	4.285	17.8	0.855	3.7
10-A	78.5	15.290	74.0	4.140	20.0	1.205	6.0
12-A	85.5	12.640	67.4	4.720	25.1	1.415	7.5
14-A	89.5	9.790	61.7	4.350	27.4	1.735	10.9
16-A	92.5	7.295	53.8	4.270	31.5	1.985	14.7
18-A	94.0	7.765	53.0	4.435	30.2	2.465	16.8
6-B	63.0	12.365	79.7	2.615	16.8	0.530	3.5
8-B	69.0	10.720	74.8	2.910	20.1	0.725	5.1
9-B	74.0	13.830	79.8	2.850	16.4	0.665	3.8
10-B	78.5	13.665	72.5	3.960	21.0	1.190	6.5
12-B	85.5	7.845	67.8	2.865	24.8	0.855	7.4
14-B	89.5	15.945	65.0	6.345	25.8	2.235	8.2
16-B	92.5	5.835	50.2	3.790	32.6	1.980	17.2
18-B	94.0	9.950	55.0	5.425	30.0	2.705	12.0
6-C	63.0	15.430	78.3	3.560	18.0	0.780	3.7
8-C	69.0	10.075	79.4	2.125	16.8	0.485	3.8
9-C	74.0	10.115	74.5	2.775	20.4	0.710	5.1
10-C	78.5	16.475	71.0	5.340	23.0	1.380	6.0
12-C	85.5	15.720	71.6	4.750	21.6	1.490	6.8
14-C	89.5	13.600	63.3	5.845	27.2	2.005	9.5
16-C	92.5	10.835	56.4	5.815	30.2	2.575	13.3
18-C	94.0	6.540	47.0	4.780	34.3	2.610	18.7

Conclusion

Data obtained by testing the original Turner Two-wheel Economy Thresher has been the basis for alterations and changes which has resulted in an improved and efficient forage plot thresher. Experimental threshing on plot work has proved satisfactory, however, the machine is larger than is necessary.

A plot thresher must rapidly and efficiently handle small quantities of material without the loss of seed.

It is imperative that the machine be clean for each run to prevent mixing of seed. Lodging of seed within the thresher may contaminate succeeding runs. Rapid clean out was made possible by reconstructing the machine so that the interior was smooth.

Tests on Alsike and Ladino clover indicate that a cylinder speed of 1300 rpm must be maintained for efficient threshing. A decrease in the amount of seed obtained is directly related to a decrease in cylinder speed.

Tests on oats and barley indicate that a cylinder speed of 675 rpm must be maintained for efficient threshing. The most desirable cylinder speed for wheat was found to be 950 rpm.

Several machine adjustments are necessary when changing from one crop to another. These adjustments necessary for efficient threshing are correct cylinder speed, proper adjustment of the chaffing screens, correct amount and direction of the air blast, and desired shaker speed.

It is important that methods and techniques for handling samples of forage plots be handled the same for all tests.

Threshability tests on Ladino clover show conclusively the effect of moisture on the per cent of seed threshed. A decrease in moisture content from 18 to 10 per cent, increased the amount of seed obtained significantly. (See chart 3.) According to the analysis it may be concluded that as the moisture increased from 10 to 18 per cent the threshability decreased, but as the moisture decreased from 9 to 6 per cent the threshability was not affected. This indicates the necessity for equal conditioning of all samples to be threshed.

The data on Table 13 shows that the seed obtained from the first threshing of a high moisture content sample will be low and the subsequent runs will be high. The reverse is true for the low moisture samples in which the seed obtained from the first threshing will be high and the subsequent runs will be low. The data shows that the amount of seed obtained from the first of three threshings of run 6-A is greater than the seed obtained from all three threshings of run 18-A. This is important, not only from an experimental viewpoint, but also as a reminder to commercial operators that Ladino clover must be threshed when the forage is at its lowest field moisture content. Ladino clover must be threshed when at a low moisture content to obtain a maximum amount of seed.

The results of Table 13 conclusively show that equal threshing techniques and methods be conducted on comparable samples between the various branch experiment stations. In comparing the yield from the same crop between branch stations it is necessary that the conditioning of these samples be equal.

EXHIBITS

The exhibits are listed in three parts for easy reference. These are:

1. Photographs. The photographs explain the construction and mosifications made on the efficient forage plot thresher developed at Oregon State College, Corvallis, Oregon.

2. Charts. The charts explain in graphic form the test work accomplished on moisture equilibrium and machine threshability on Ladino clover.

3. Plates. The plates show the major changes performed on the Turner Two-wheel Economy Thresher in development of an efficient forage plot thresher.

Figure 1
An experimental forage plot thresher developed at Oregon State College, Corvallis, Oregon. This thresher is easily towed by automobile or truck.

Figure 2
A yard square sample of oats being taken by Malcolm Johnson, Project Leader, Deschutes Experimental Area, Redmond, Oregon. Clover samples are also taken in this manner.

Figure 3
A row sample of barley wrapped in the field. Shattering of seed occurs in this operation.

Figure 4
Wrapped samples of grain in a confused mass. Excessive shattering of seed occurs in handling and storing.

Figure 5

The sack on the left contains a yard square sample of clover while the wrapped bundle on the right is grain from a rod length row. An experimental forage plot thresher must efficiently handle samples of this size.

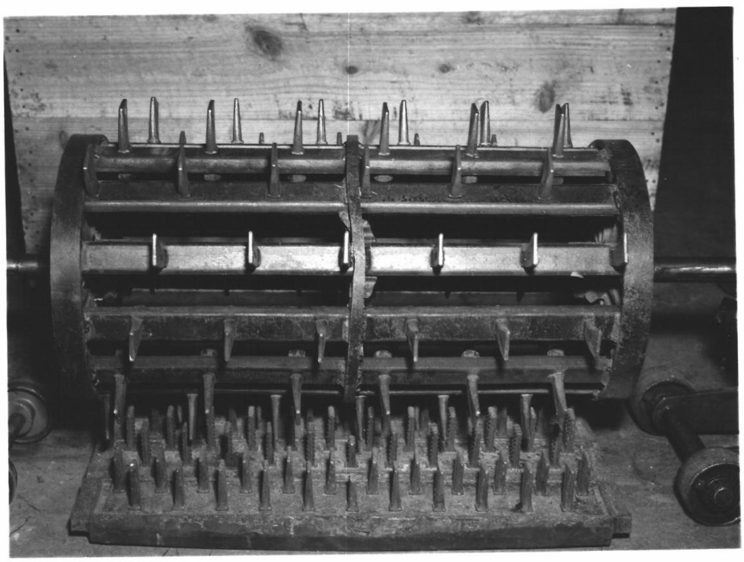

Figure 6

Rice cylinder (peg-toothed cylinder) and concave used in the early experimental threshing operations. The concave is composed of three sections. The middle section has corrugated teeth and the outer sections smooth teeth.

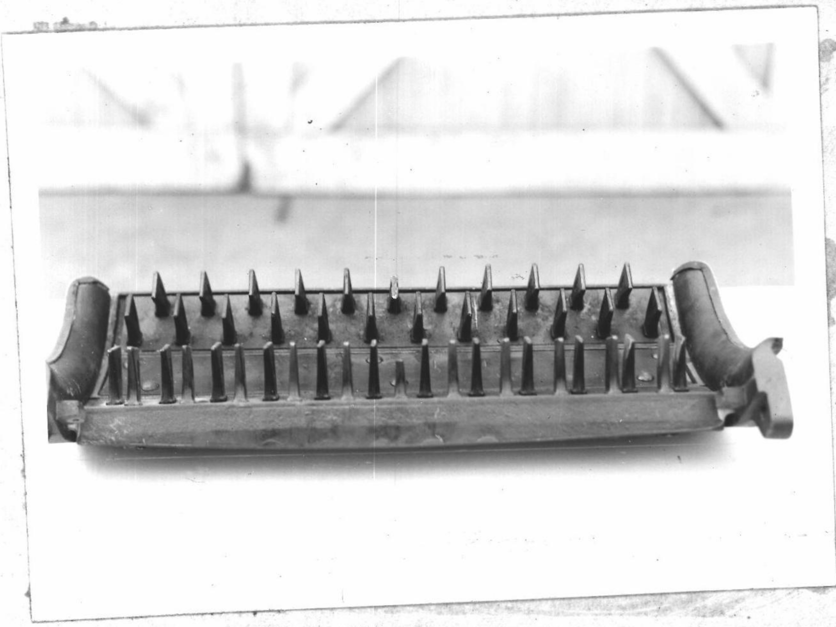

Figure 7
The peg-toothed concave with center section void of teeth. Note the rubber strips cemented to the outside of concave sides to effect a tight fit in the machine.

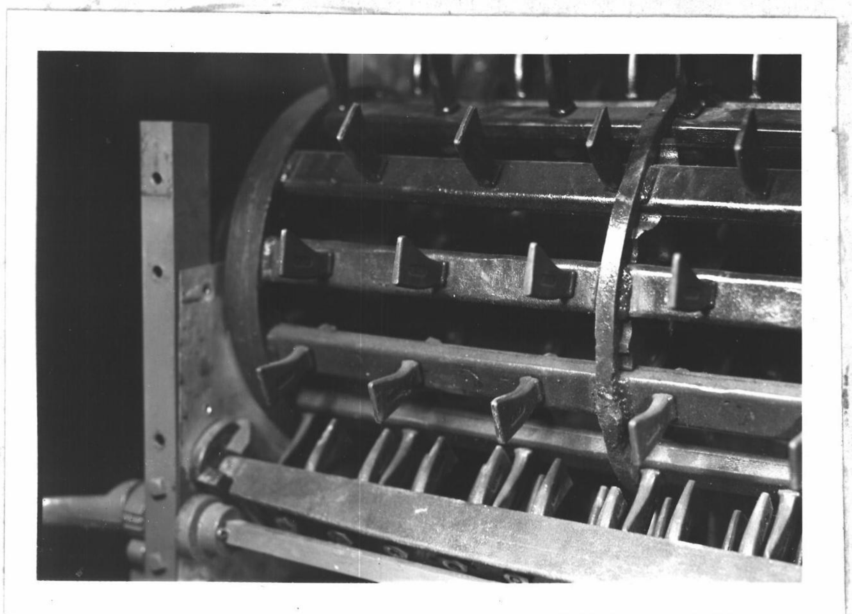

Figure 8
The rice cylinder and concave assembled in the machine. Ratchet assembly, in lower left side of picture, regulates the clearance between cylinder and concave.

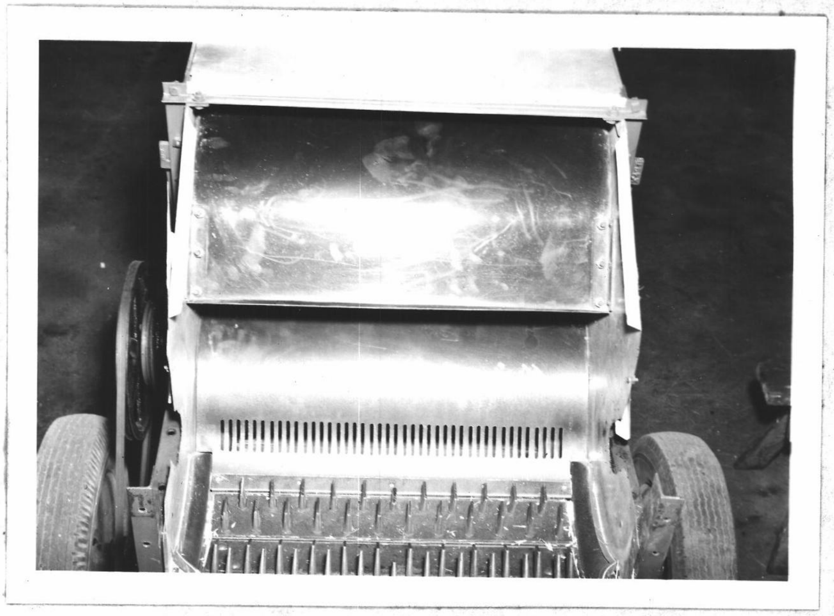

Figure 9

Top view of the peg-toothed concave with grate-de flector mounted behind. Vertical seed slots allow the escape of seed from the concave housing. This seed drops onto the return pan directly behind the grate-deflector.

Figure 10

The original wood straw rack which came equipped with the Turner thresher. Notice the cracks and crevices conducive to seed lodging.

Figure 11
The original bottom shaker unit without the cleaning sieves and grain screen. Note the corrugated return at the top and also the corrugations on the bottom seed pan. Seed movement and lodging was not desirable with this arrangement.

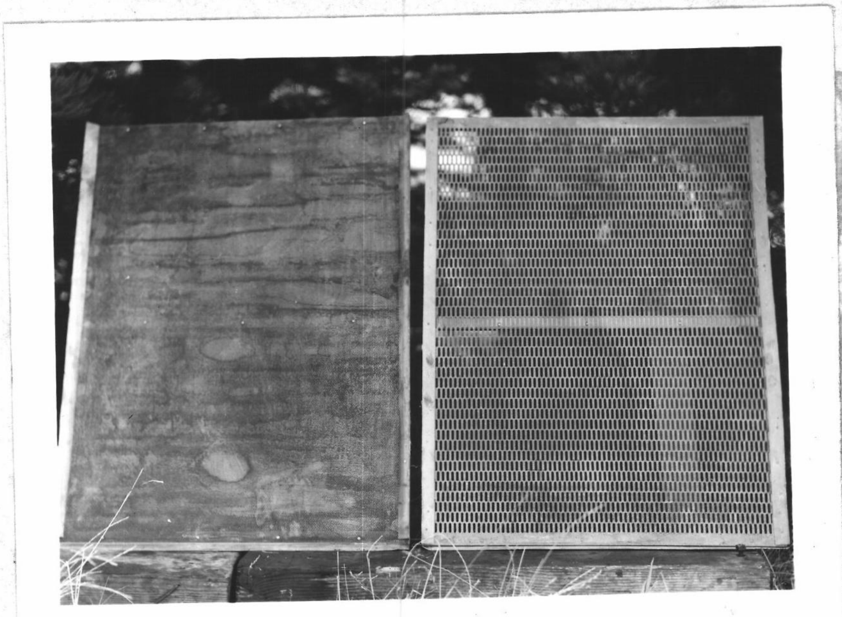

Figure 12
These two seed screens were used on all experimental tests. The Ladino and Alsike clover screen on the left has 5/64 inch openings. The screen used for grain is on the right.

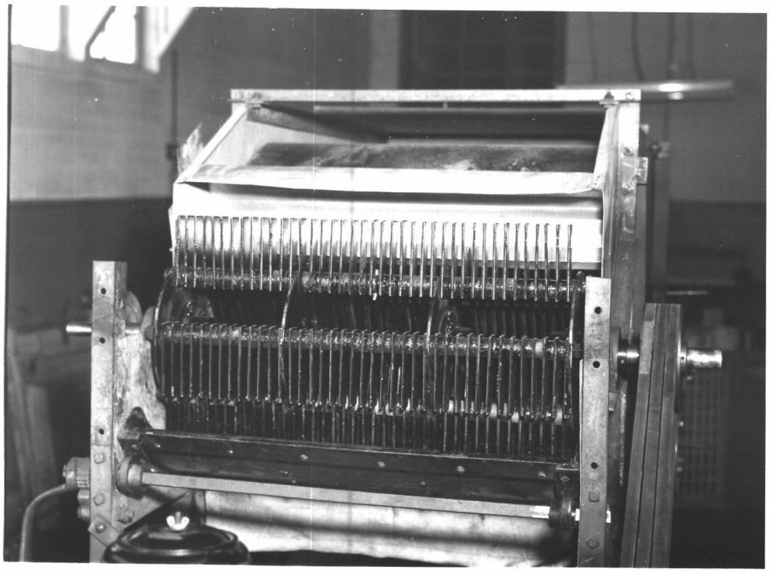

Figure 13
Swinging hammer cylinder, equipped with 243 swinging bars, replaced the rice cylinder shown in figure 6.

Figure 14
Five stationary plates form the concave which is used with the swinging hammer cylinder pictured in figure 13. Smooth-on cement was used to seal the crack formed at the junction of the concave and grate-deflector.

Figure 15

This view shows the bottom shaker unit. The return pan is above and the seed pan is below. Sloping sides effect rapid movement of seed to the seed chute.

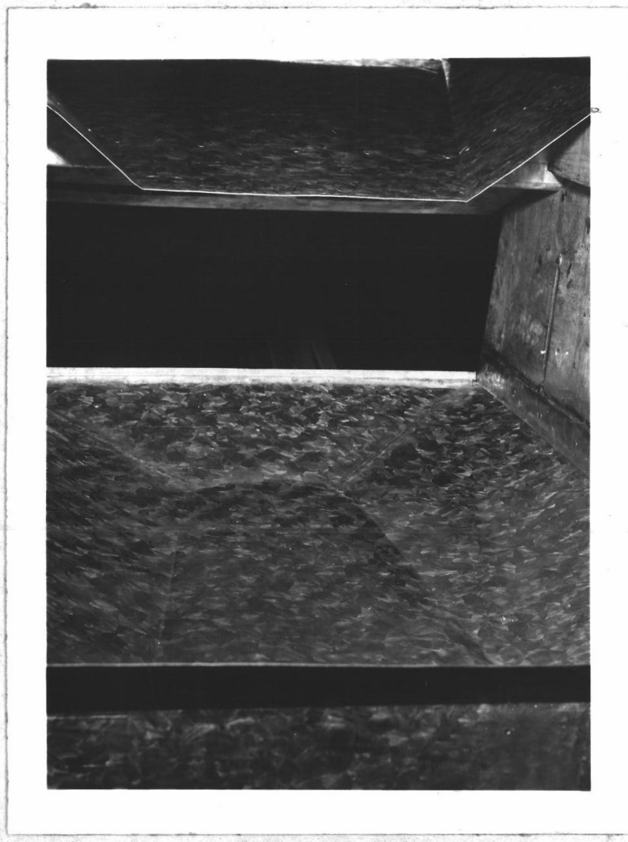

Figure 16

This picture shows the return pan and the bottom shaker pan as they appear from the discharge end of the thresher.

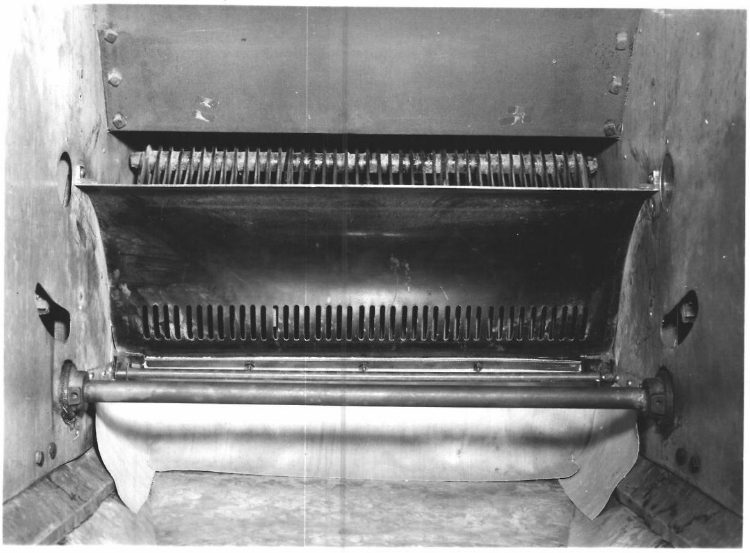

Figure 17

Threshed seed comes through the vertical slots in the grate-deflector and fall upon the return pan. A canvas check at the rear of the pan prevents seed loss at the back side.

Figure 18

The redesigned straw rack. Tailings discharge at the far end. Small curved plates, shown on the far side of the shaker plate, direct seed in toward the holes.

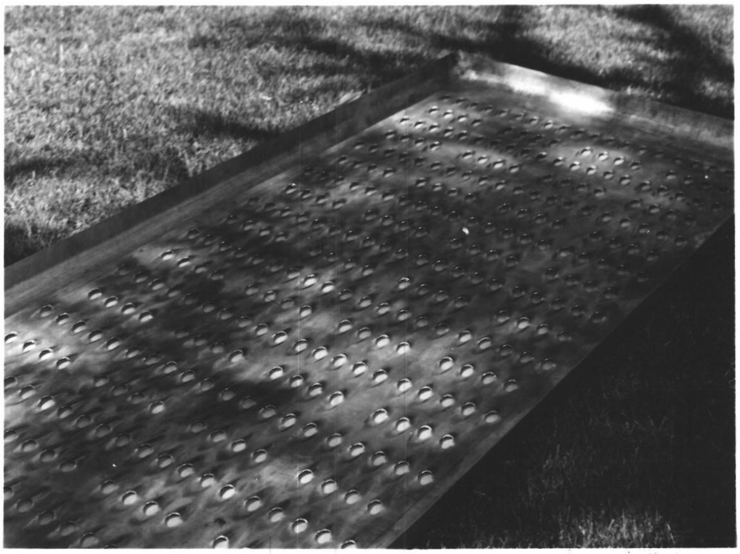

Figure 19

This straw rack was constructed of 18 gauge sheet steel. Note the seed holes with depressions on the discharge side and the raised lip on the cylinder side. The raised lip helps to push the straw rearward and the depressions cause the seed to drop to the seed pan shown in figure 20.

Figure 20

The seed pan, directly beneath the straw rack conveys seed to the return pan.

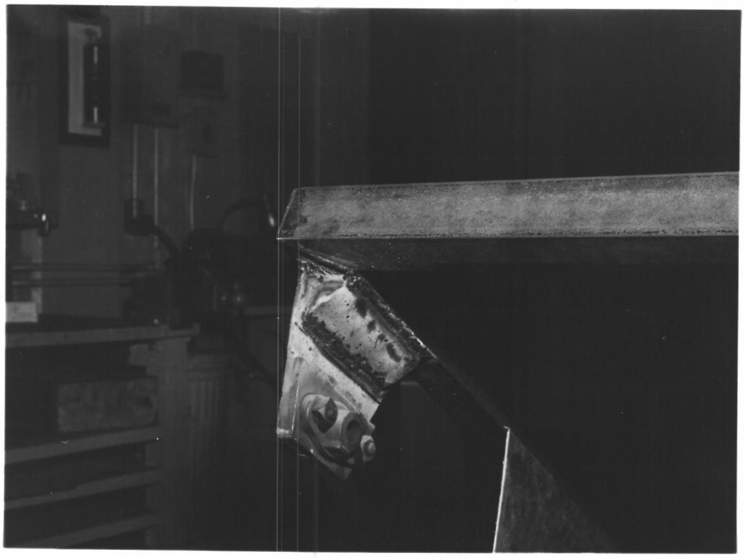

Figure 21
The framework of the straw rack was welded tightly to prevent lodging of seed and chaff.

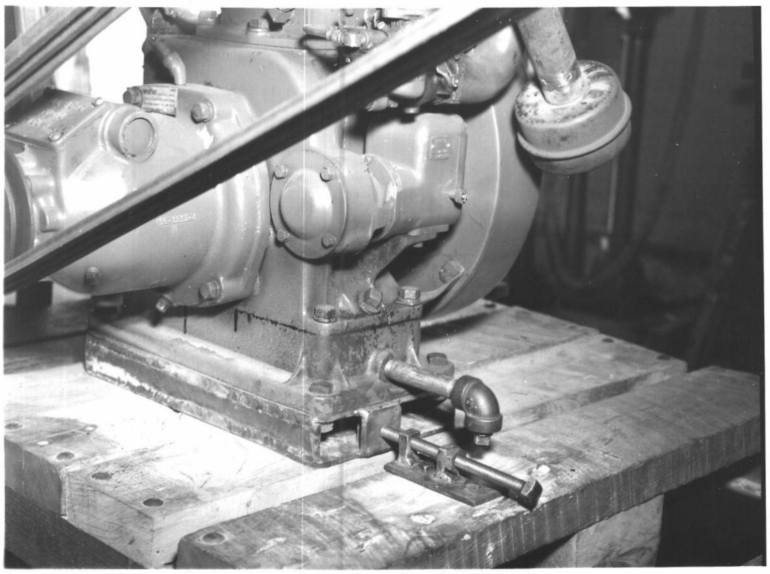

Figure 22
The motor mount and tightener mounted on the wood platform of the thresher. Easy adjustment of belt tension is obtained with this arrangement.

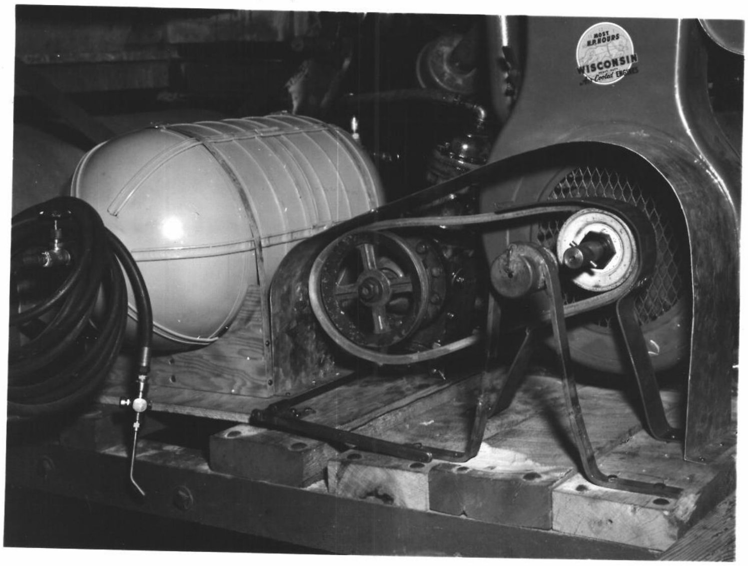

Figure 23

The compressor mount and tightener, belt guard, belt guide, and compressor tank mount. Twenty feet of flexible hose on the compressor allows easy cleaning of all parts of the thresher.

Figure 24

Air deflectors are shown mounted in the air passage coming from the fan housing. The amount and direction of air is adjusted with the top and bottom plates.

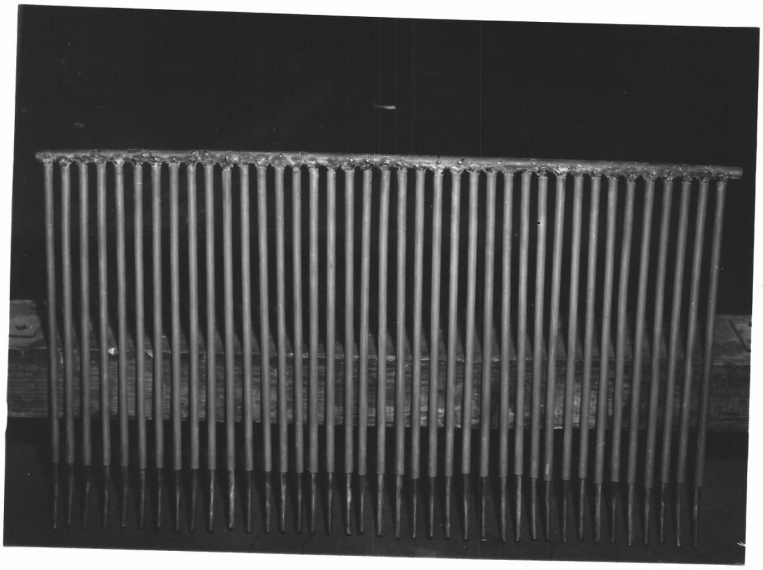

Figure 25

A finger deflector, mounted above and in the front of the straw rack, retard the movement of straw coming from the cylinder and directs it onto the rack. Rubber tubing protects the seed from skuffing and cracking.

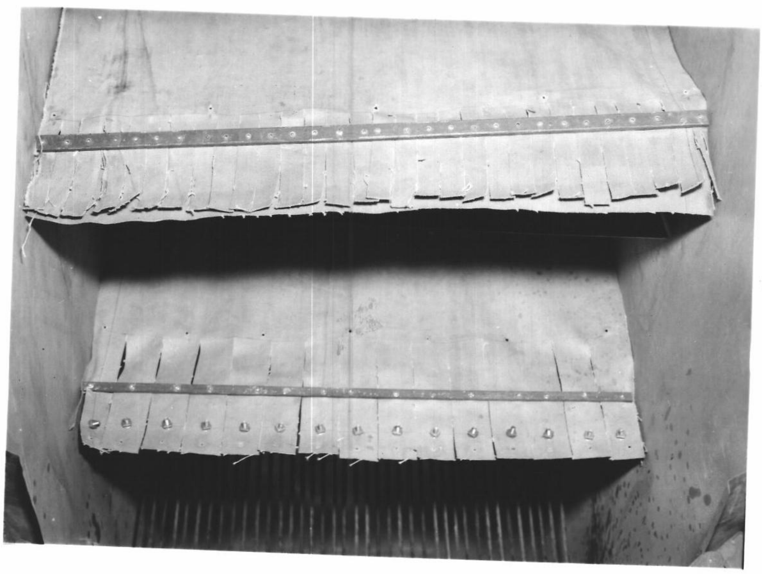

Figure 26

Canvas checks between the finger deflector and the discharge end of machine retards the flying seed, and causes them to fall to the straw rack.

Figure 27
The belt tightener maintains proper belt tension and reduces belt "flop." Note the angle and strap iron welded to the thresher frame for strengthening.

Figure 28 (Next page)

The Fiber Flax Conditioner-Drier used in the moisture equilibrium and threshability studies on Ladino clover. The letters on the photograph refer to the list in Apparatus. This conditioner is part of the basic research work on moisture equilibrium studies of fiber flax started by C. Ivan Branton and being completed by N. R. Brandenburg, Bureau Plant Industries, Soils, and Agricultural Engineering, U.S.D.A., Oregon State College, Corvallis, Oregon.


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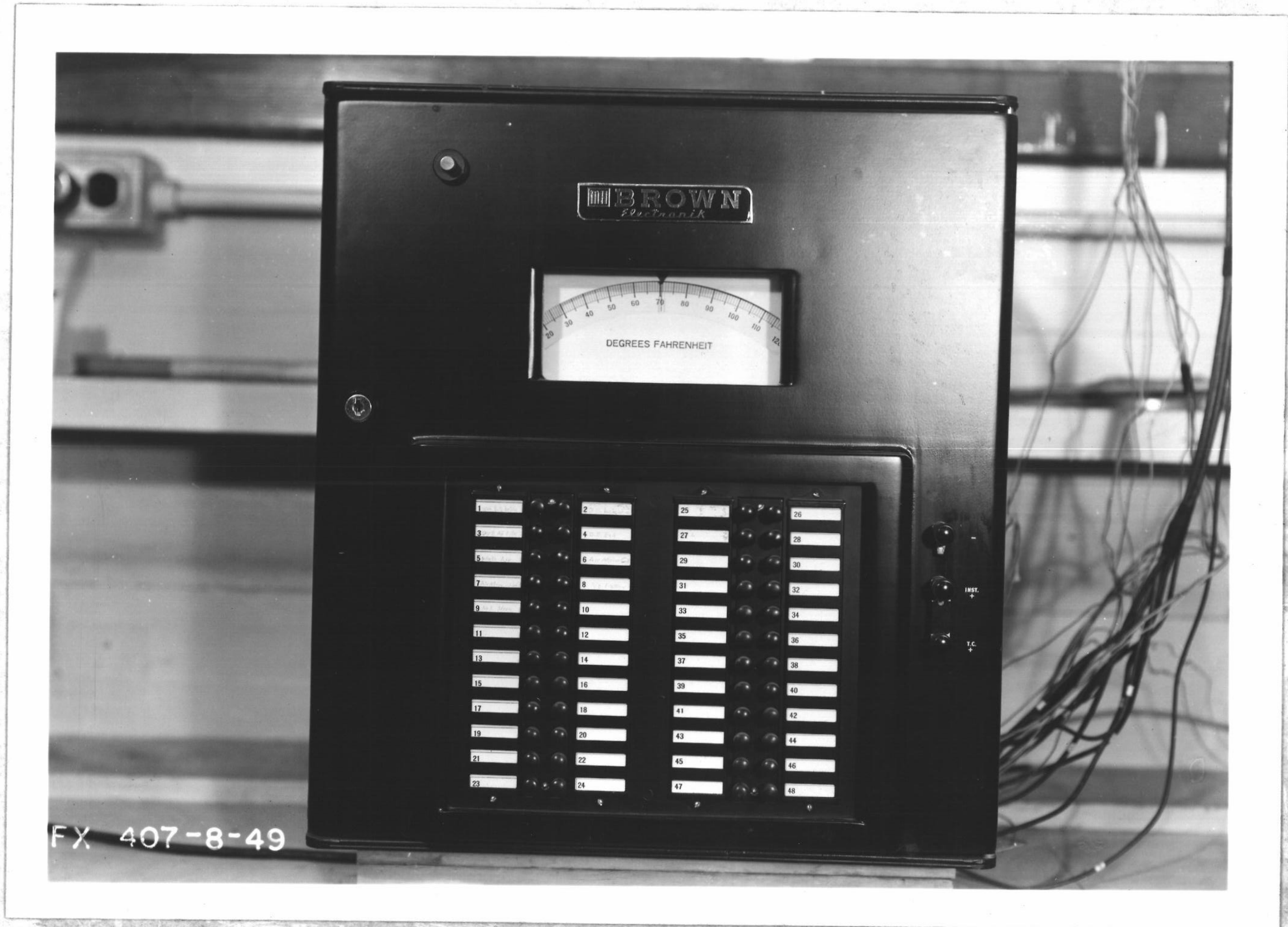

Figure 29

A "Brown Electronik" potentiometer pyrometer with thermocouples was used in recording the wet bulb and dry bulb temperatures in the conditioner-drier.

Figure 30

On the left is the "Scientific Supplies Co." heat oven and on the right the "Braun Kreht-Heimann" analytical balance used in the laboratory tests. In the foreground are the aluminum baskets and the airtight moisture cans.

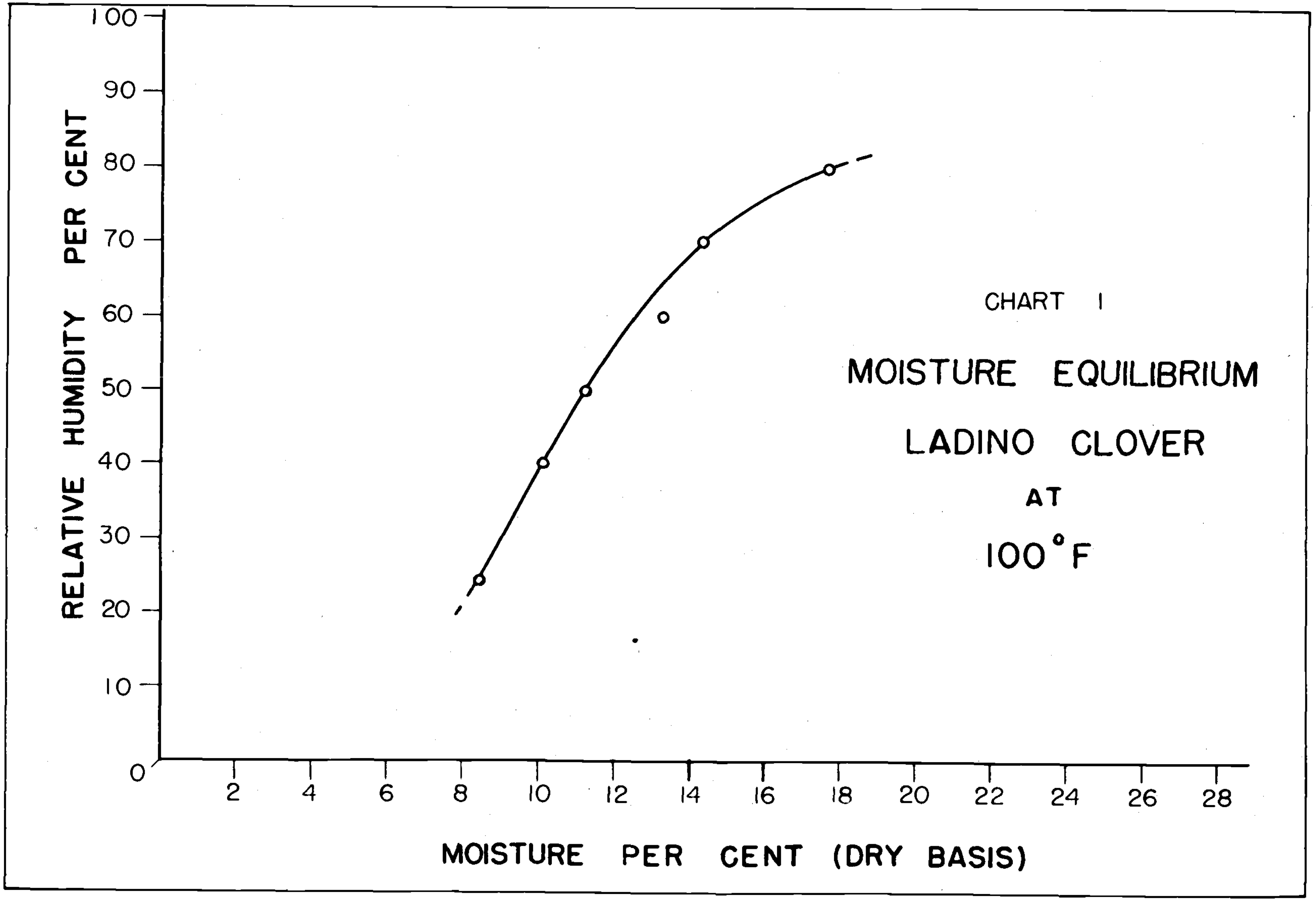
CHART I
MOISTURE EQUILIBRIUM
LADINO CLOVER
AT
100°F
RELATIVE HUMIDITY PER CENT
MOISTURE PER CENT (DRY BASIS)
100
90
80
70
60
50
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4
6
8
10
12
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22
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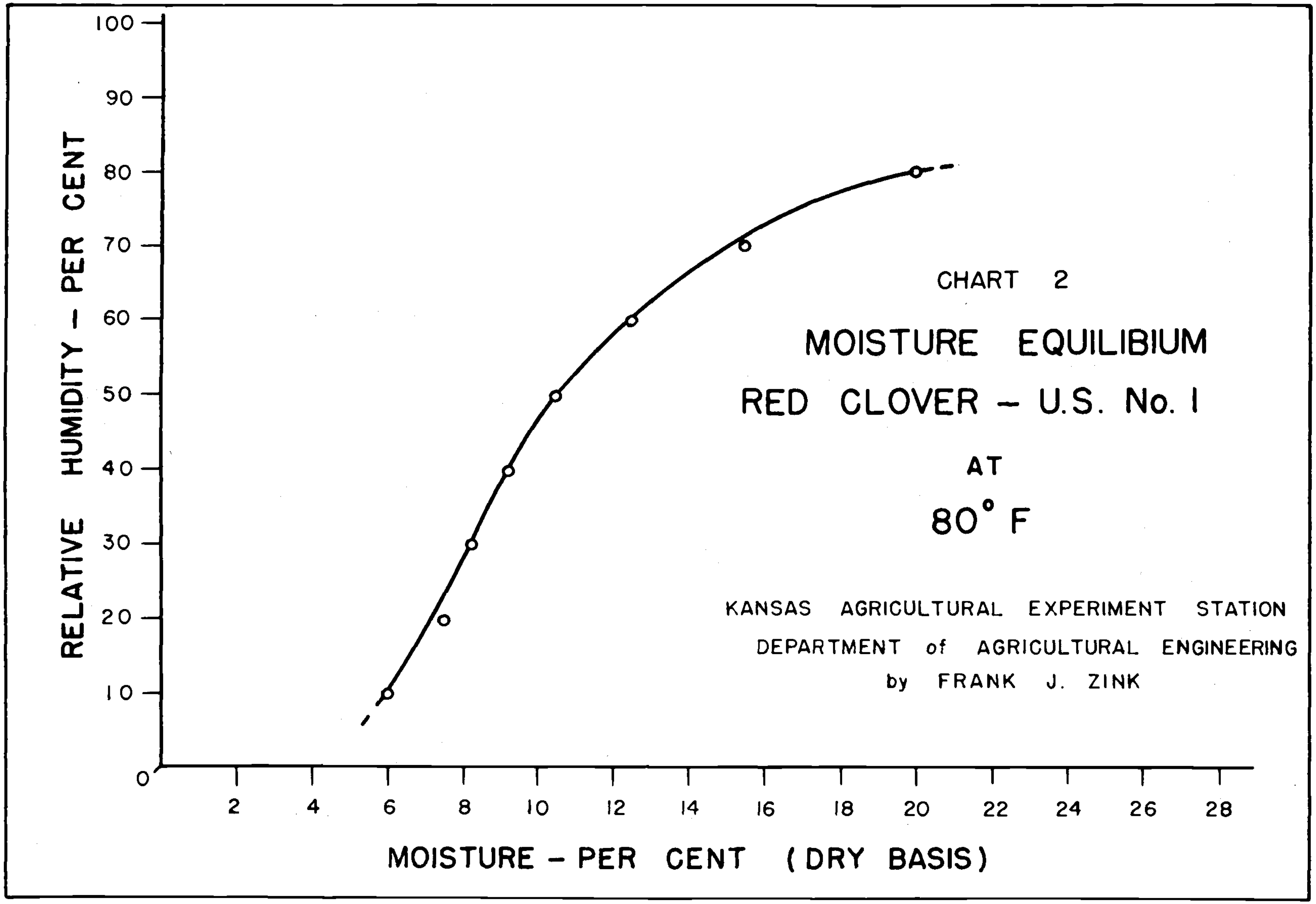
CHART 2
MOISTURE EQUILIBIUM
RED CLOVER – U.S. No. 1
AT
80° F
KANSAS AGRICULTURAL EXPERIMENT STATION
DEPARTMENT of AGRICULTURAL ENGINEERING
by FRANK J. ZINK
RELATIVE HUMIDITY – PER CENT
MOISTURE – PER CENT (DRY BASIS)
0
10
20
30
40
50
60
70
80
90
100
2
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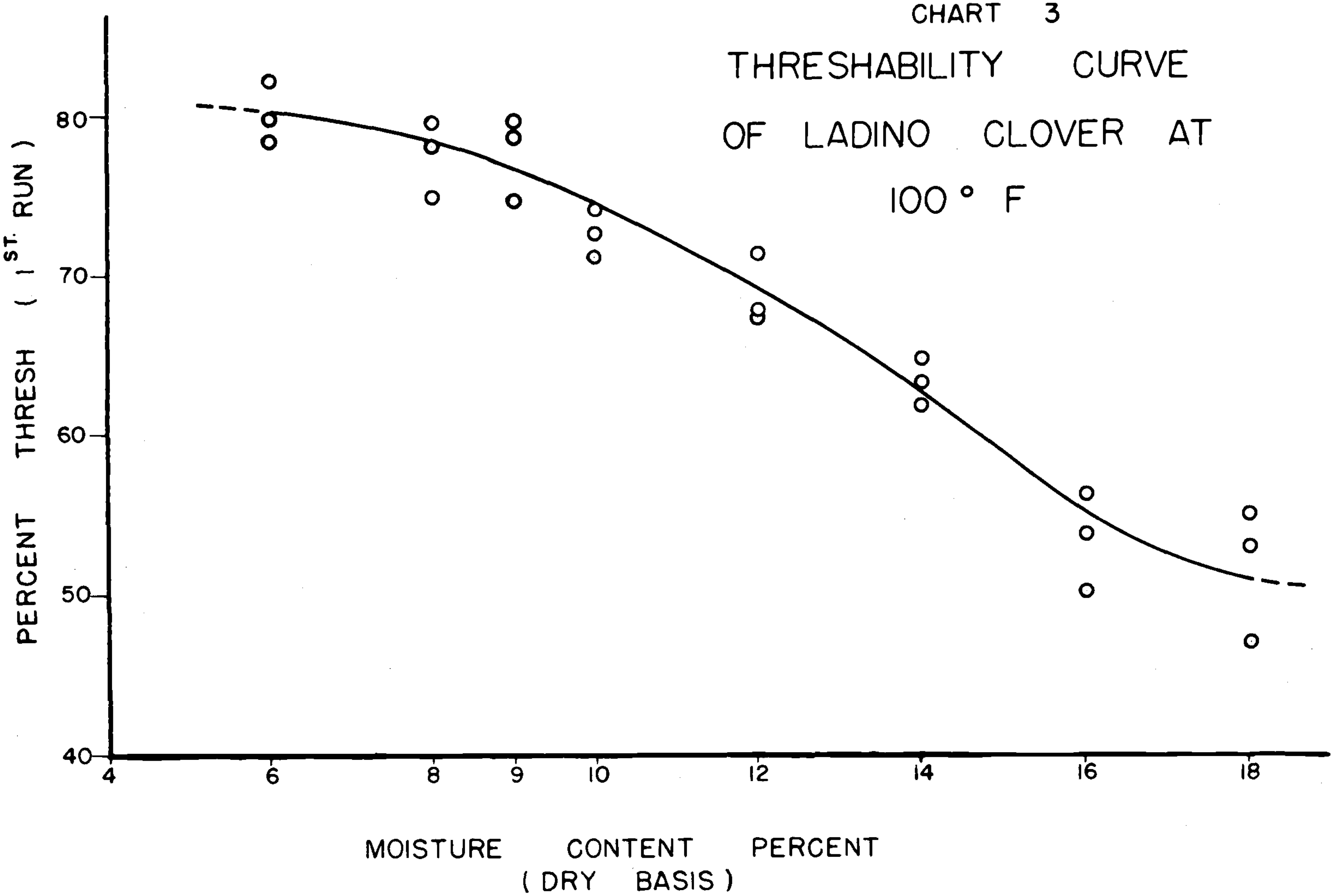
CHART 3

THRESHABILITY CURVE OF LADINO CLOVER AT 100 ° F



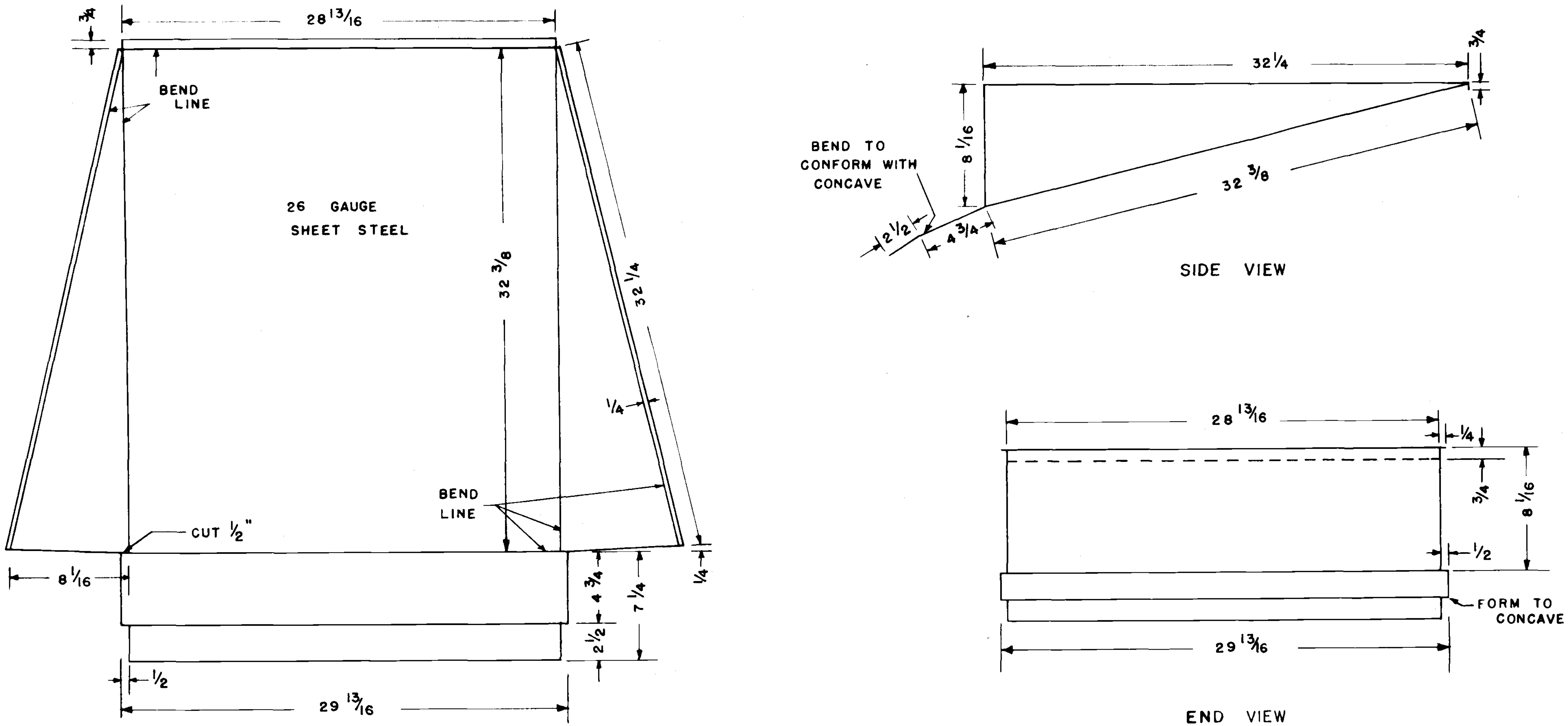
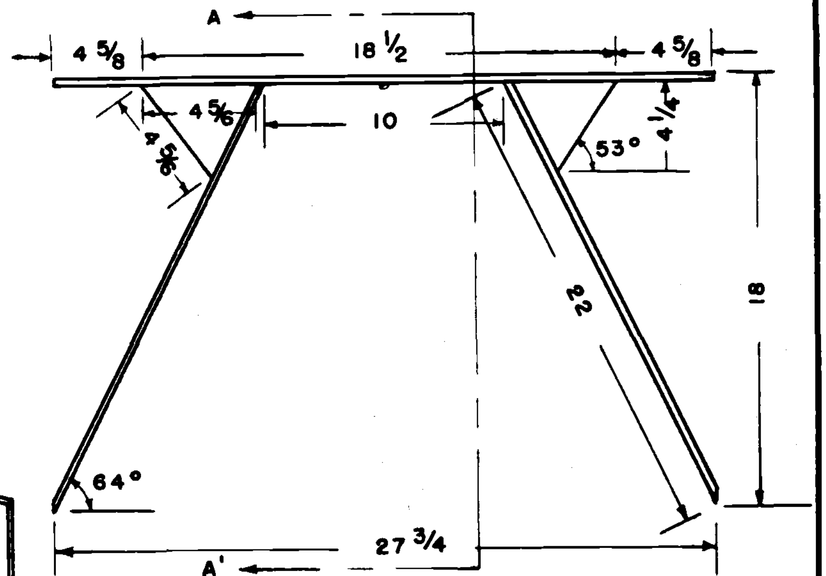


PLATE No. 1

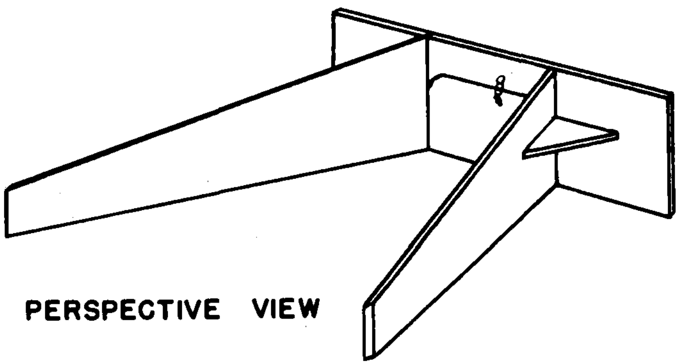
SHEET METAL FEEDER TABLE

SCALE 1/8" = 1"

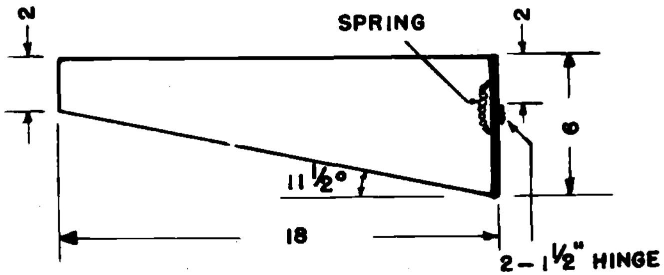


TOP VIEW

CONSTRUCT WITH
1/4 PLYWOOD



PERSPECTIVE VIEW



SECTION — A A'

PLATE No. 2

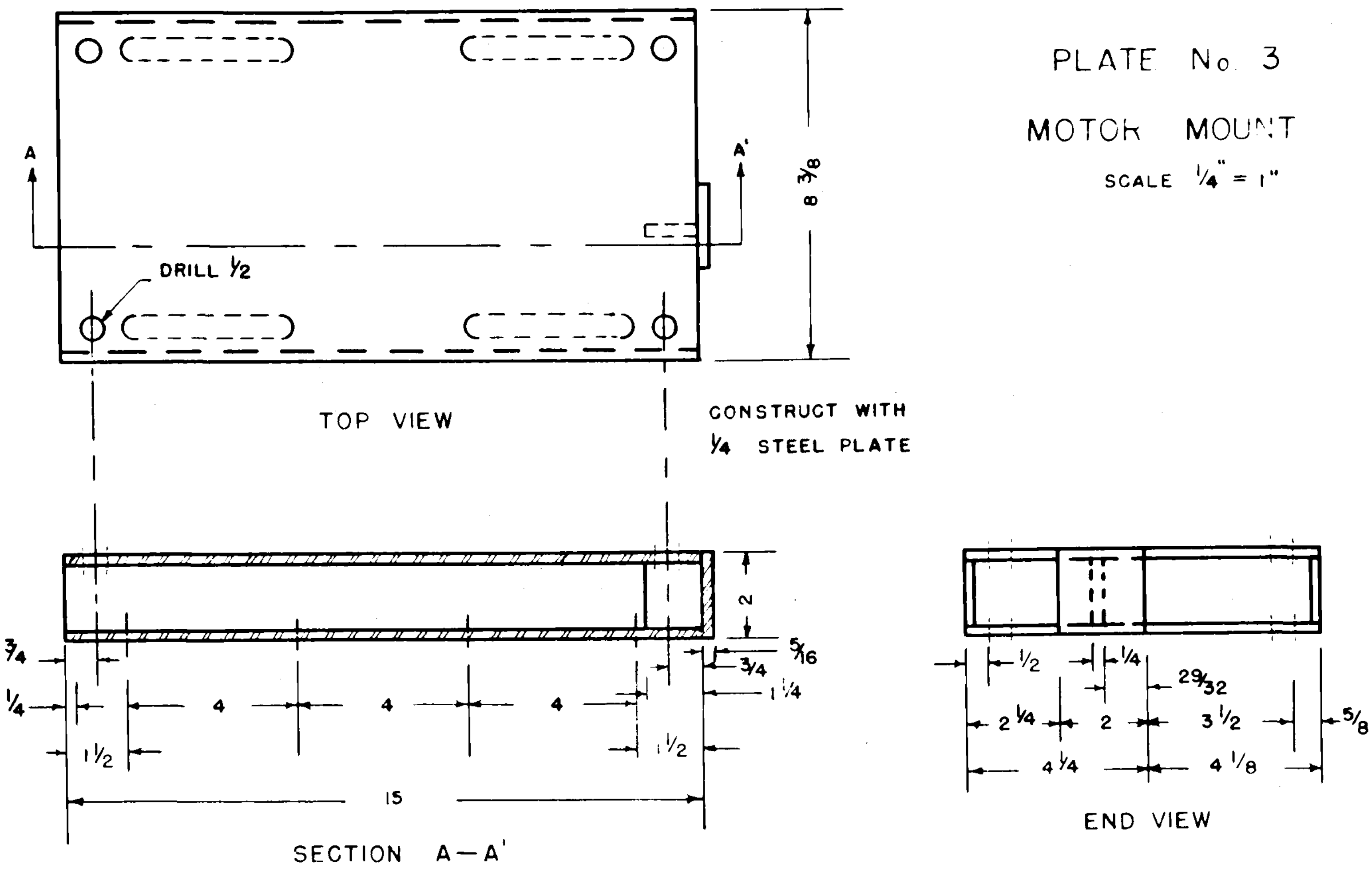
FEEDING TROUGH

SCALE 1/8" = 1"

PLATE No. 3

MOTOR MOUNT

SCALE 1/4" = 1"



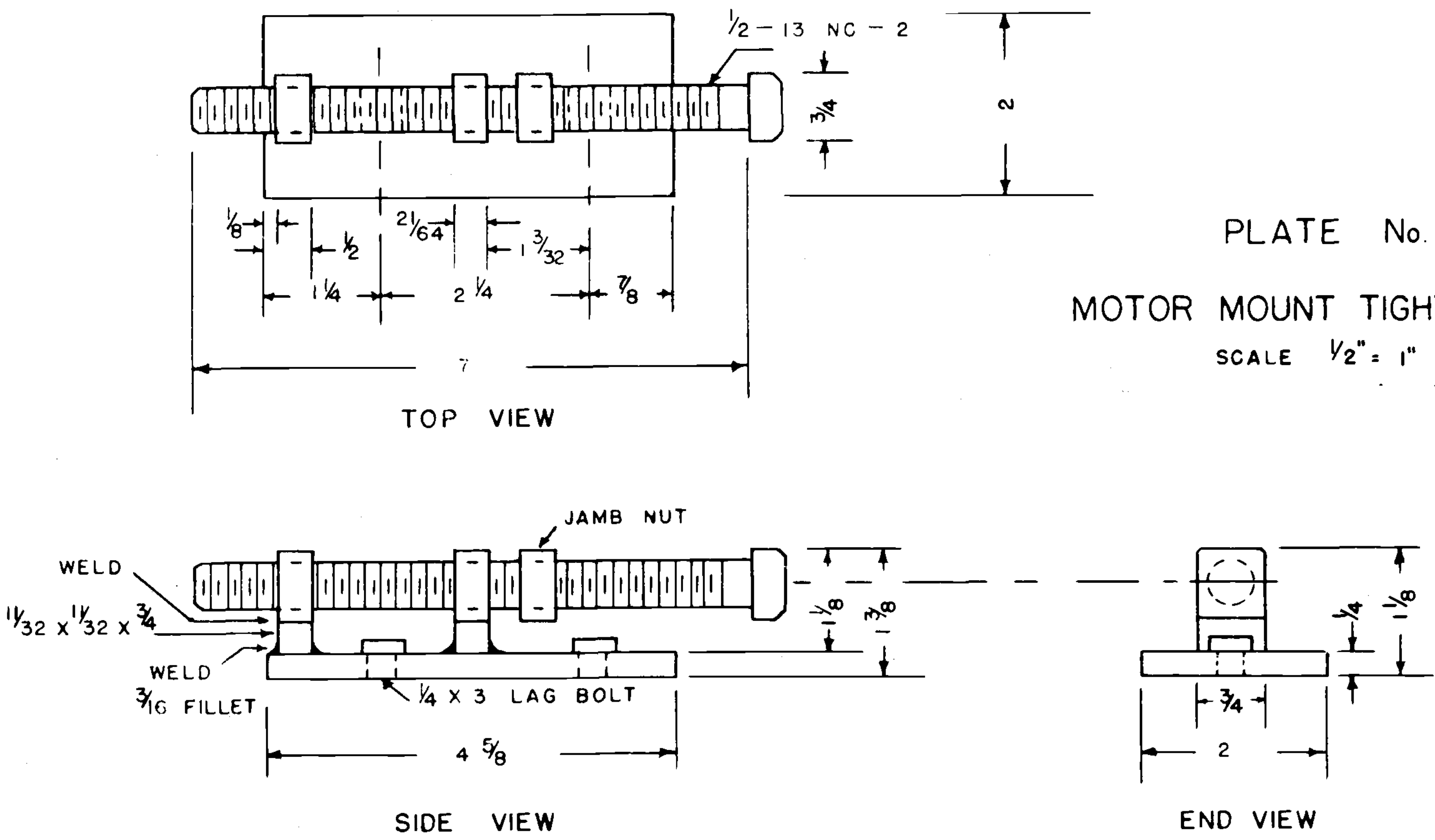


PLATE No. 4

MOTOR MOUNT TIGHTNER

SCALE 1/2" = 1"

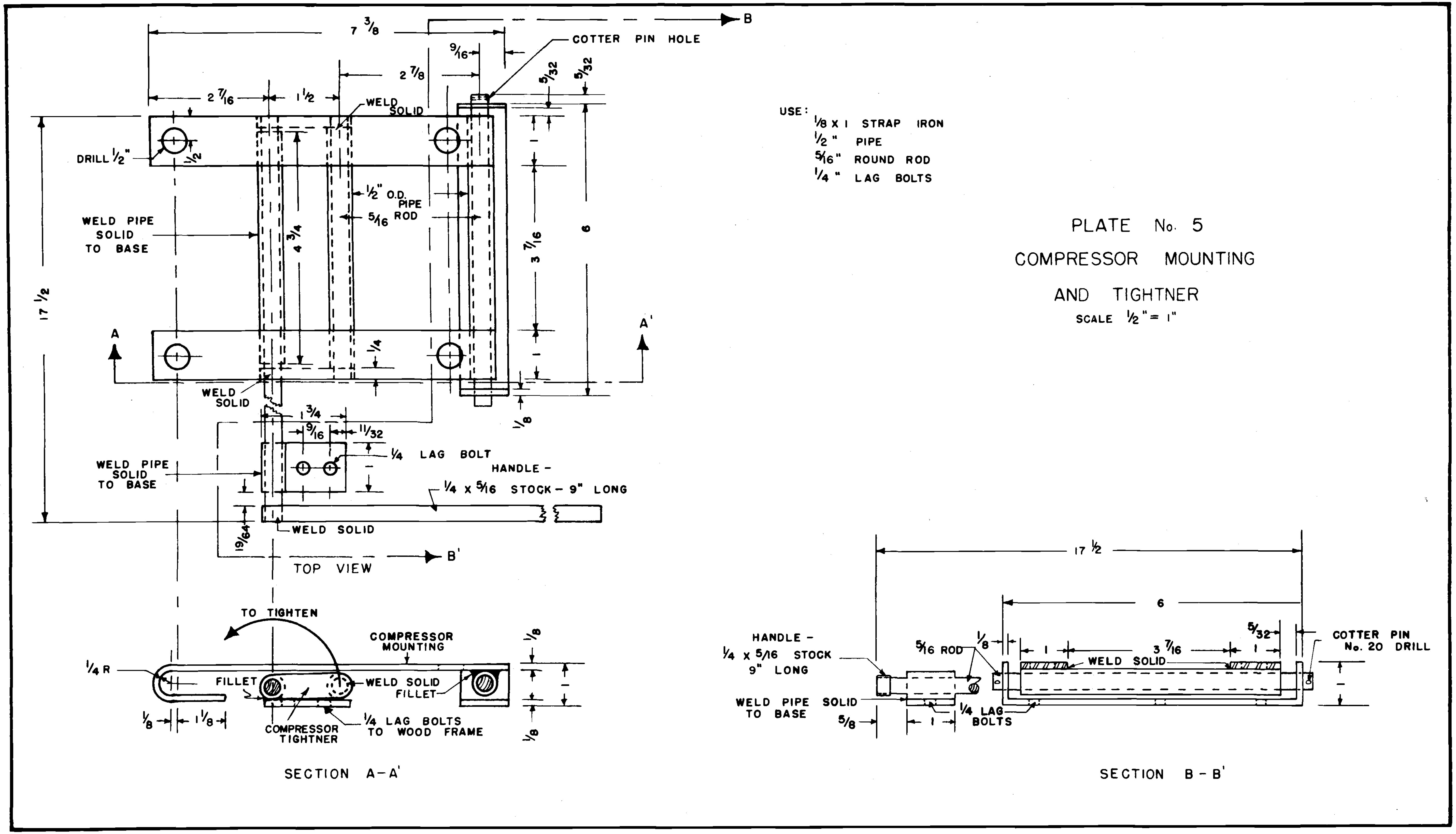


PLATE No. 5

COMPRESSOR MOUNTING AND TIGHTNER

SCALE 1/2" = 1"

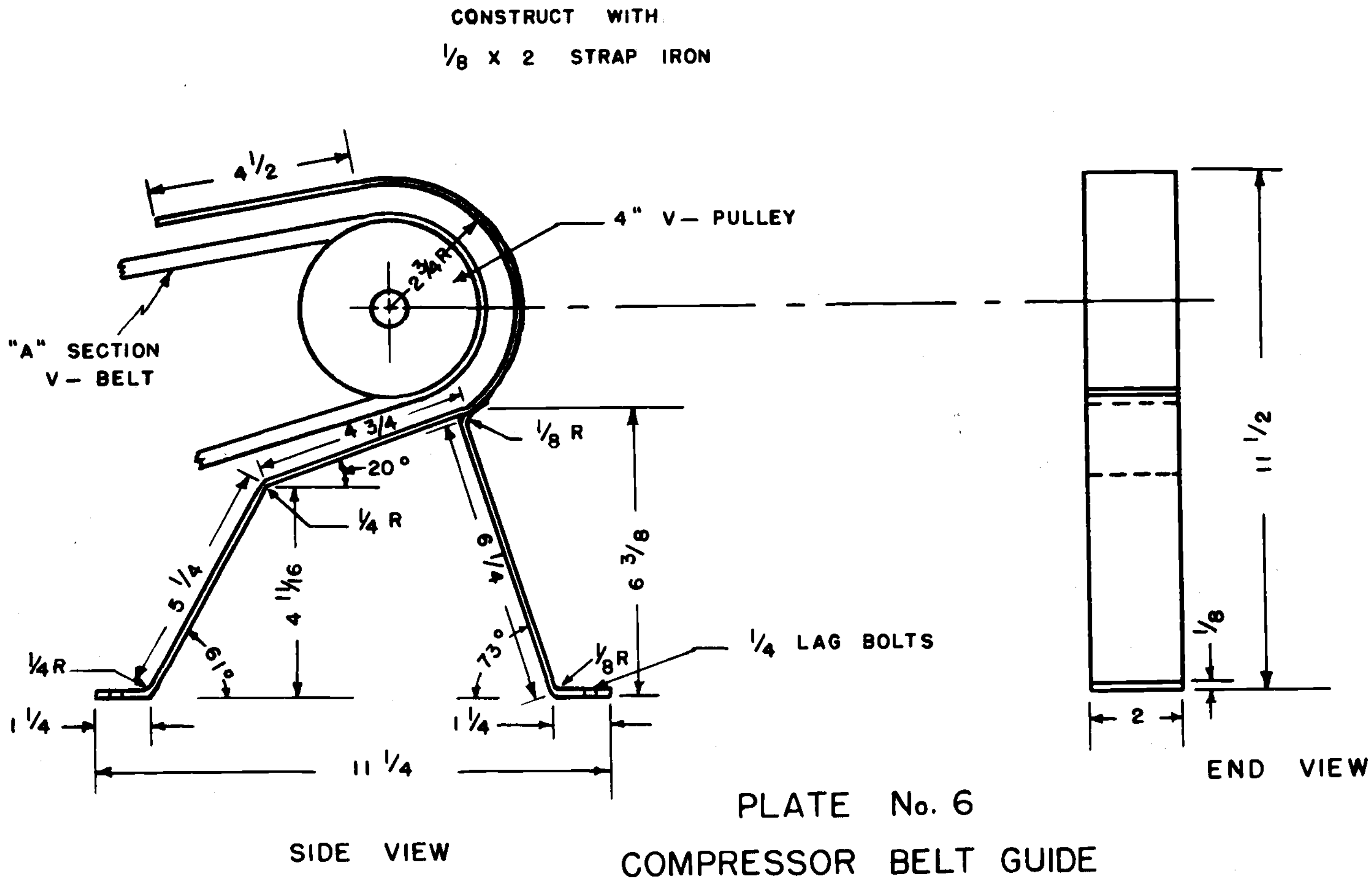


PLATE No. 6

COMPRESSOR BELT GUIDE

SCALE 1/4" = 1"

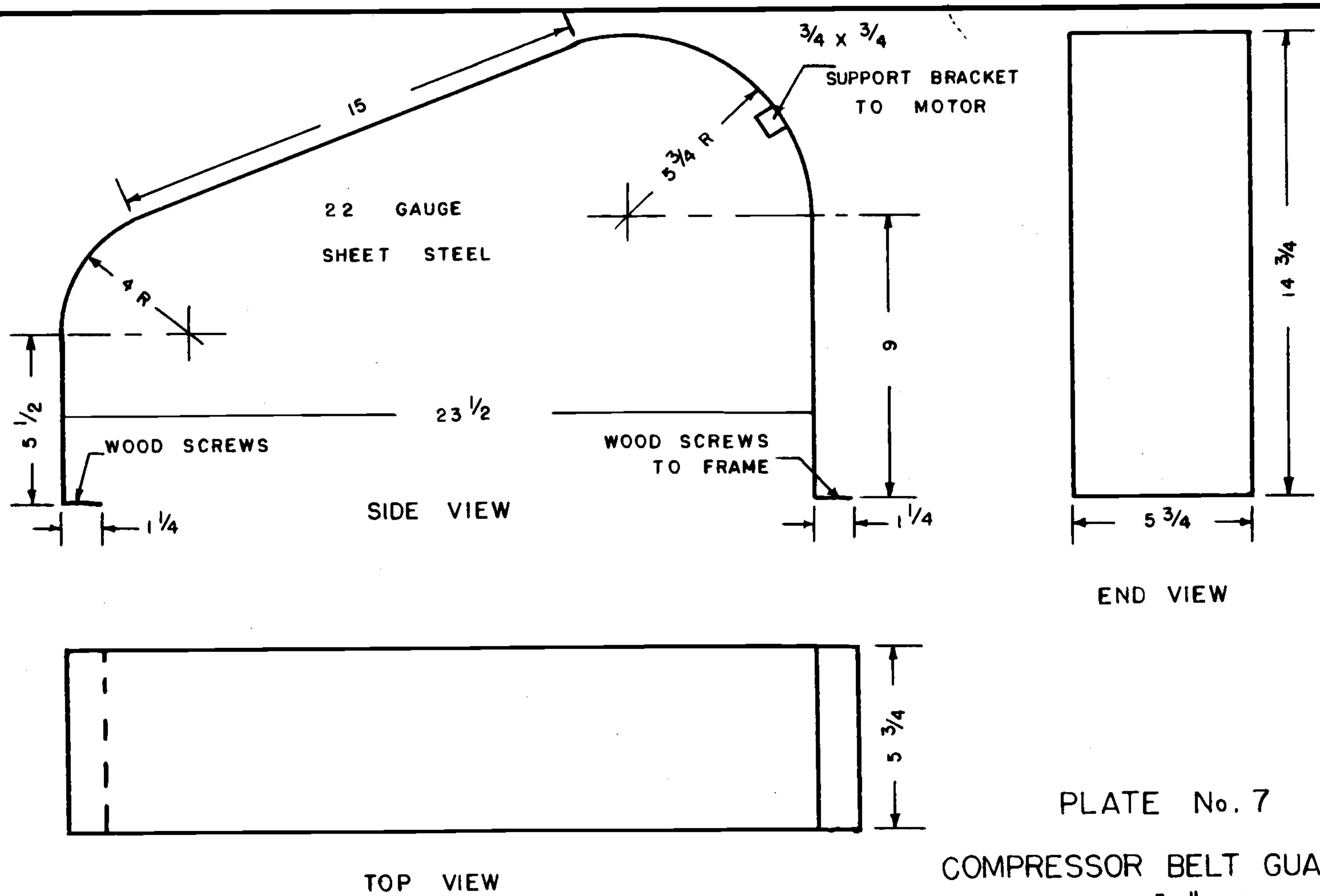
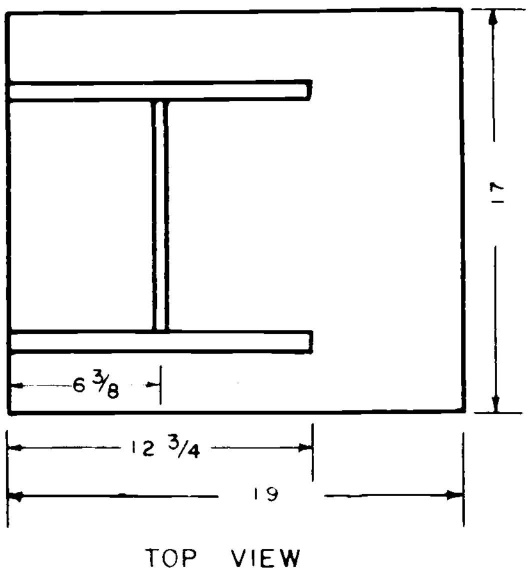


PLATE No. 7

COMPRESSOR BELT GUARD

SCALE 3/16" = 1"



CONSTRUCT WITH 3/4 PLYWOOD

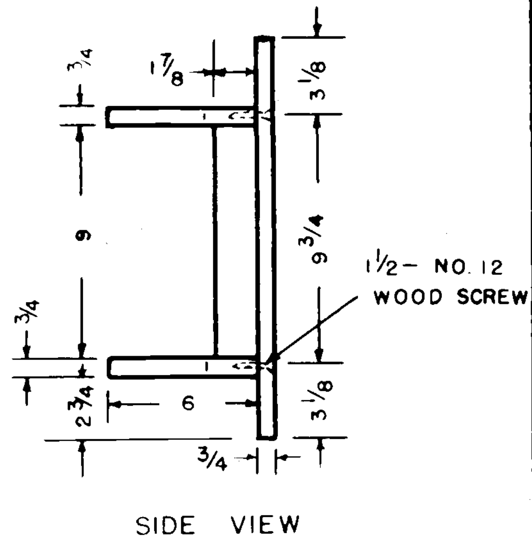
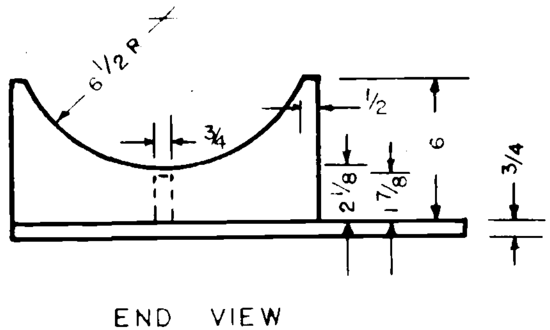
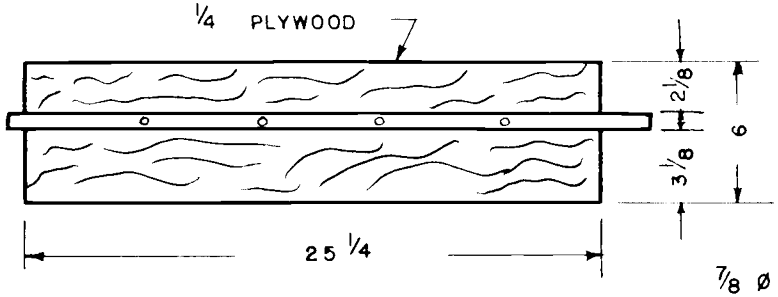


PLATE No. 8

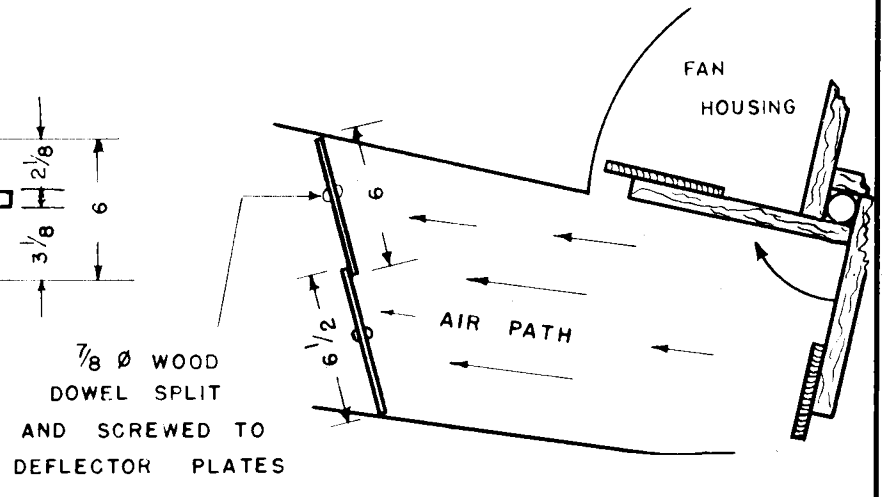
COMPRESSOR TANK BASE

SCALE 1/8" = 1"

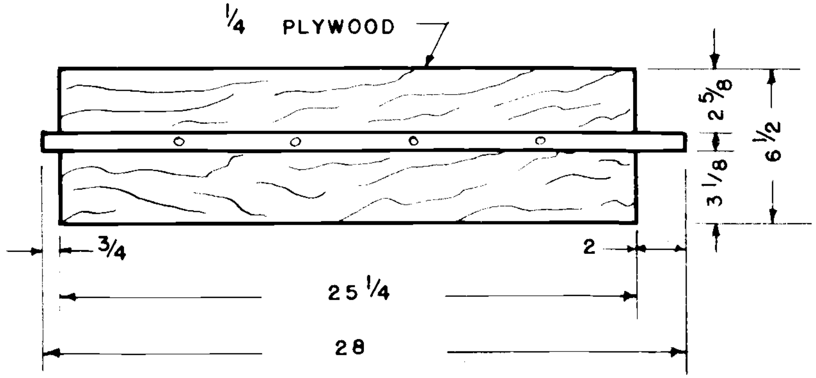




SIDE VIEW — TOP PLATE



ASSEMBLY DETAIL



SIDE VIEW — BOTTOM PLATE

PLATE No. 9

AIR DEFLECTORS

SCALE 1/8" = 1"

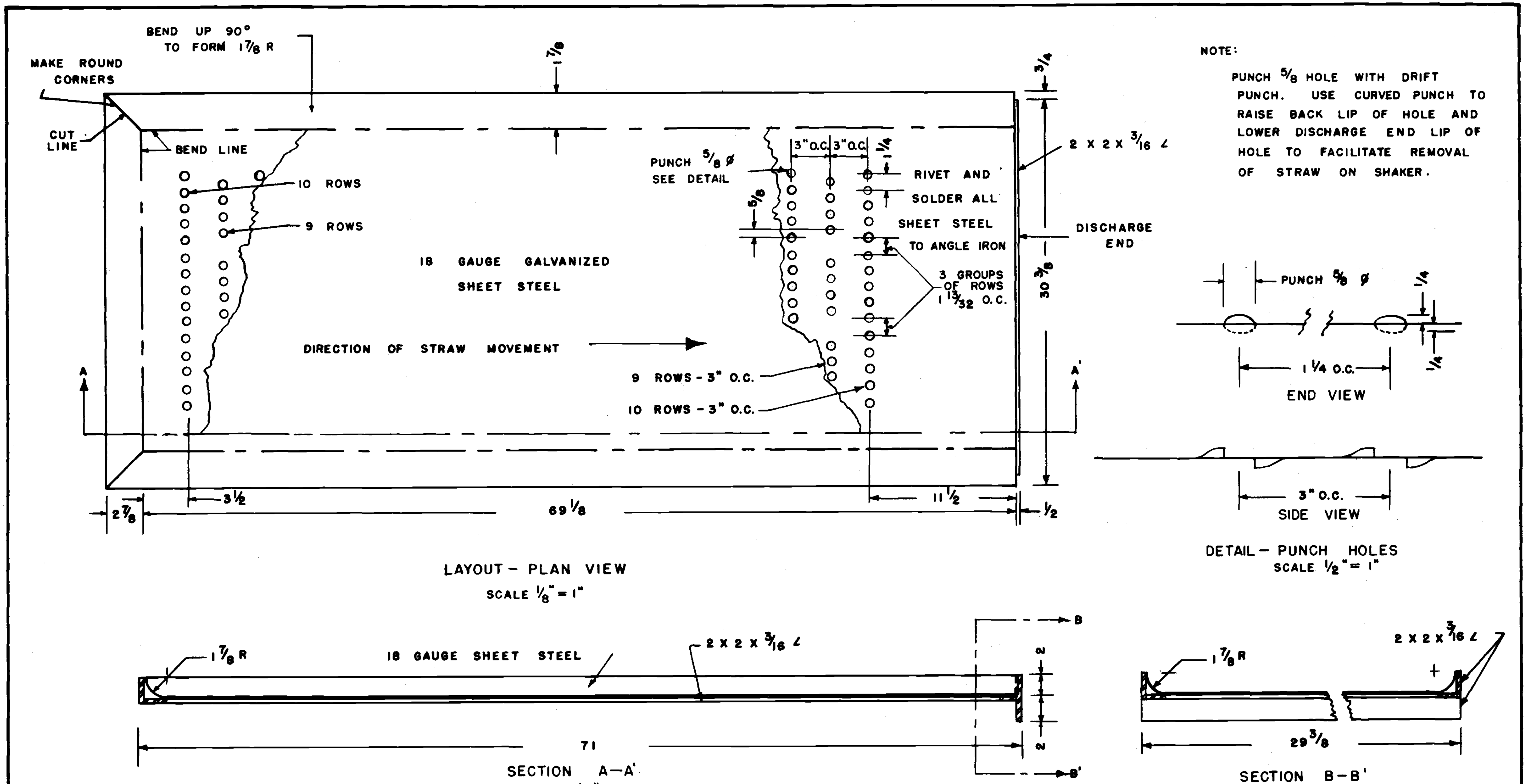


PLATE No. 10

SHAKER PLATE LAYOUT — DETAIL

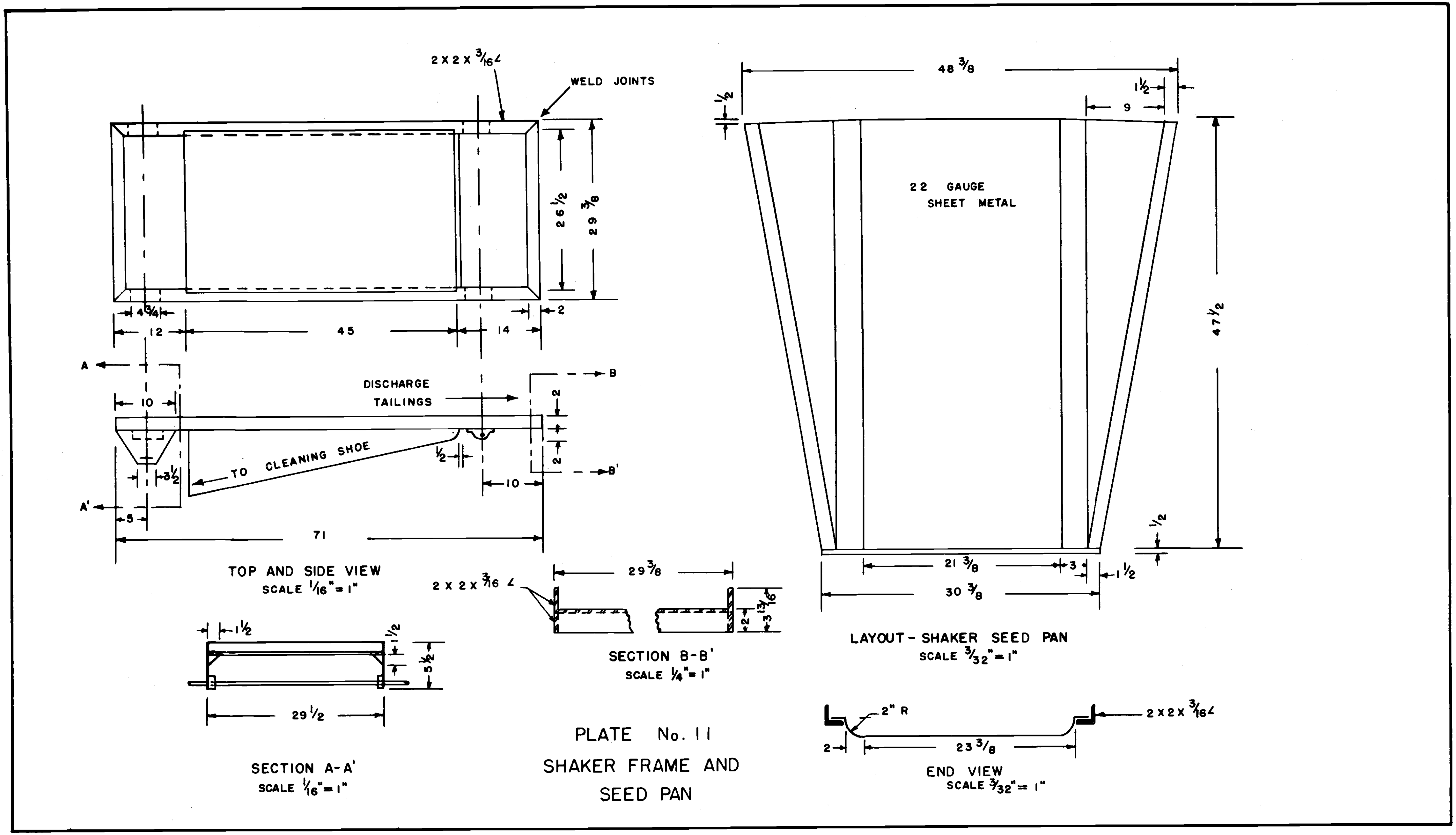
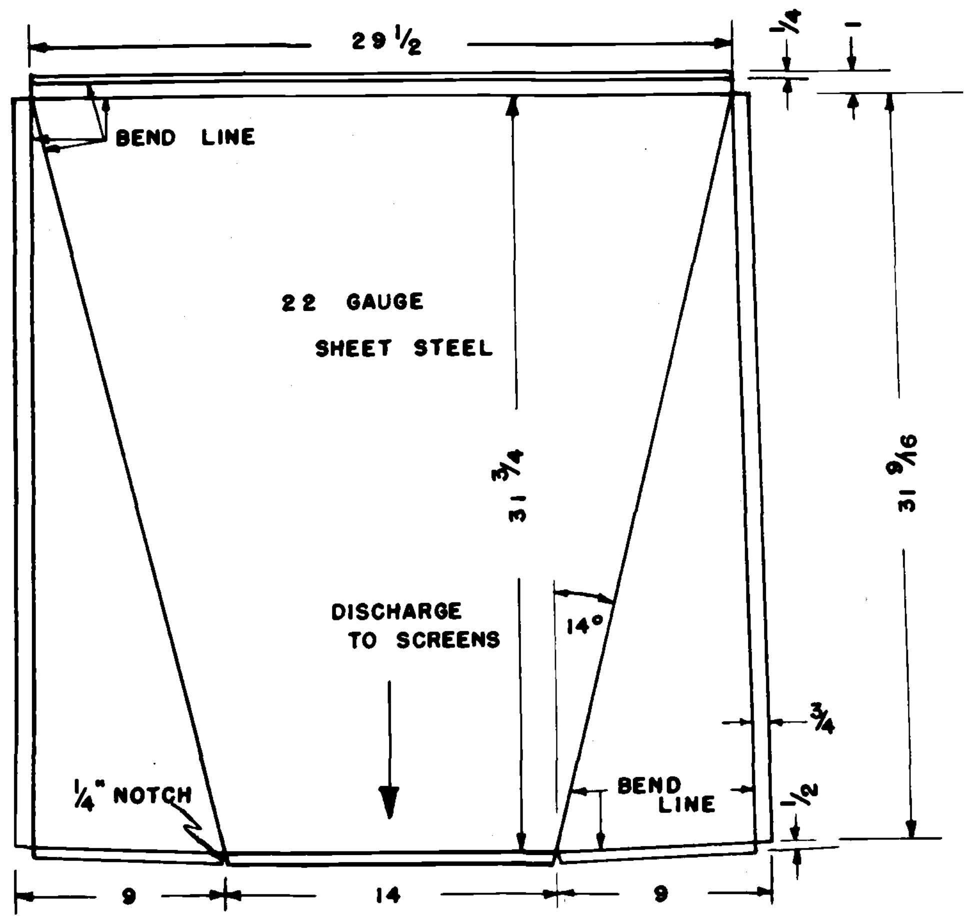
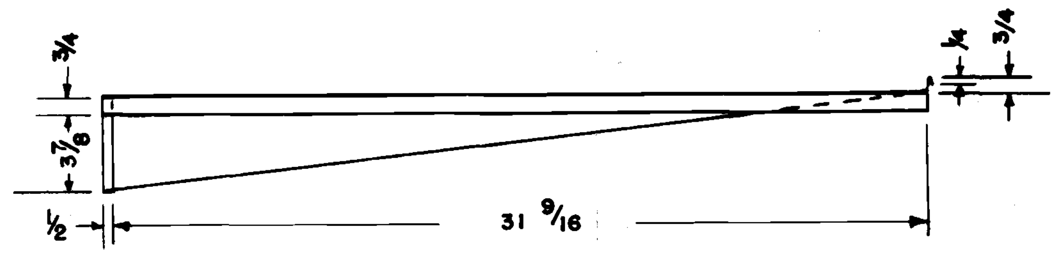


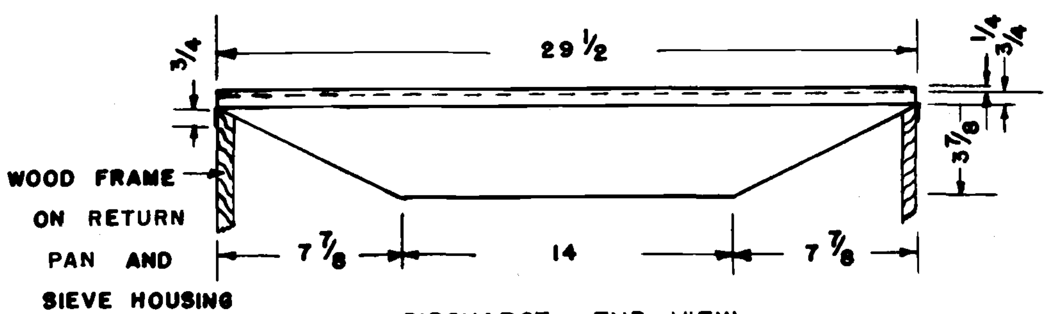
PLATE No. 11
SHAKER FRAME AND
SEED PAN



LAYOUT – RETURN PAN



SIDE VIEW

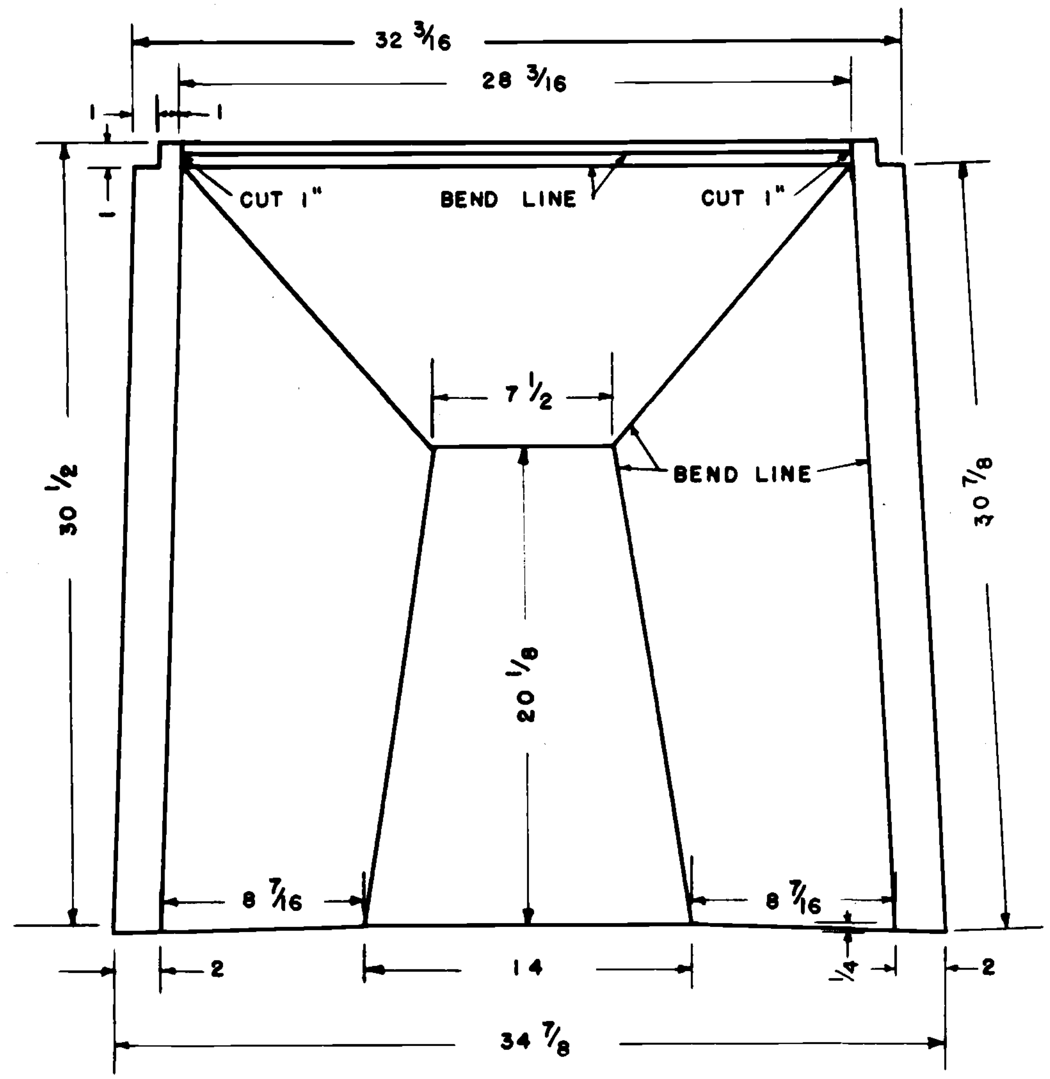


DISCHARGE – END VIEW

PLATE No. 12

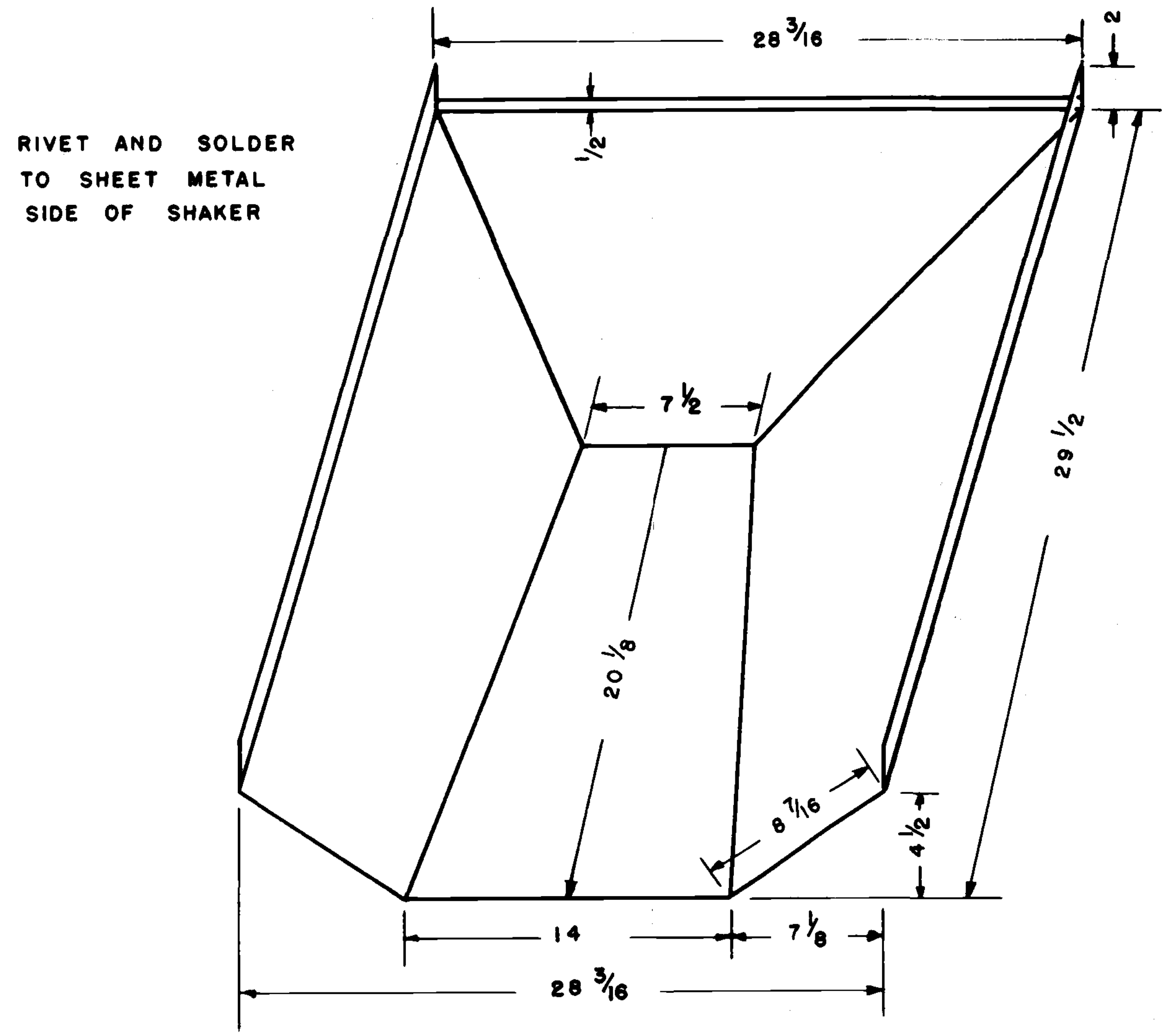
RETURN PAN

SCALE 1/8" = 1"



LAYOUT

BOTTOM SHAKER PAN



PICTORIAL VIEW

BOTTOM SHAKER PAN

PLATE No. 13

SHAKER SEED PAN

SCALE 1/8" = 1"

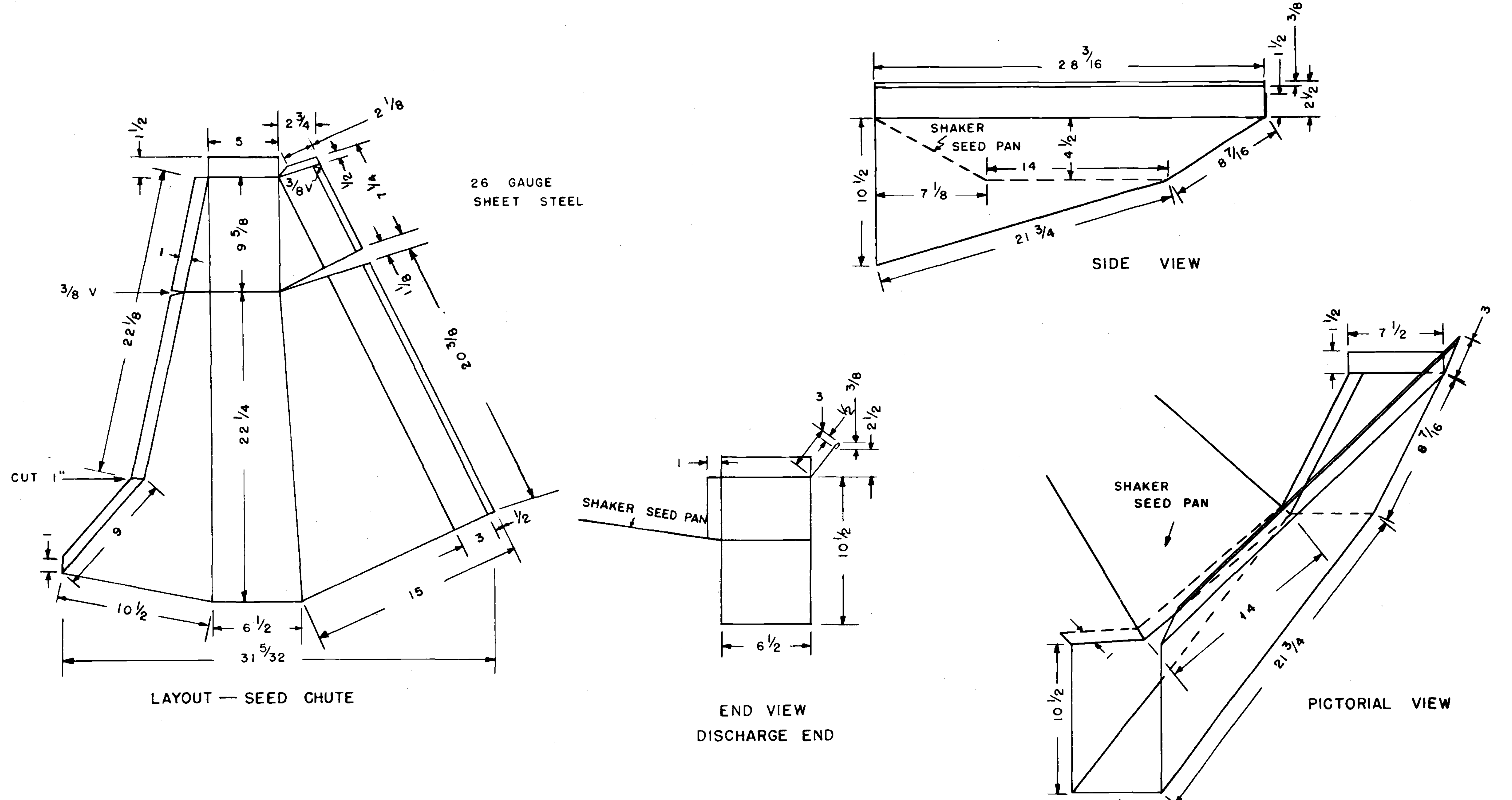


PLATE No. 14

SEED CHUTE

SCALE 1/8" = 1"

BIBLIOGRAPHY

1. Hawthorn, Leslie R. Successful small thresher. Seed World 64:28-46. February 7, 1949.

2. Jones, L. G., et al. Alfalfa seed harvesting. California Agriculture 4:8-16. Aug., 1950.

3. Schwendiman, John L., et al. Processing seed of grasses and other plants to remove awns and appendages. Washington, Govt. printing office, Circular 558, 15p., June, 1940.

4. Zink, Frank J. Equilibrium moisture of some hays. Agricultural Engineering 16:451-452. 1935.