THERMAL APPLICATOR FOR FIELD CROPS

By

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PREFACE

The study reported in this thesis was conducted as a part of Regional Research Project 578, "Mechanized Cotton Harvesting in Oklahome," of the Oklahoma Agricultural Experiment Station.

The writer is grateful to Professor Jay G. Porterfield, the thesis adviser, for his counsel and encouragement throughout this study. Appreciation is also expressed to Assistant Professor David G. Batchelder for his assistance and suggestions in carrying out this research.

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CHAPTER I

INTRODUCTION

The application of thermal energy to biological systems of growing plants is the subject of additional research each year. Continuing studies in the areas of off-field and field grain drying systems, flame weeding of various crops, applications of heat as an insecticide and thermal defoliation of cotton and other crops has increased the fund of knowledge about the response of biological material to high temperature-short exposure thermal energy. Relatively less new information has been developed about machines to accomplish the optimum application of heat to biological material.

Defoliation of cotton is an important harvest preparatory operation. When the leaves fall from the plant, defoliation has occurred. When the leaves are desiccated, but do not fall from the plant, then desiccation has occurred. Operations intended to accomplish either defoliation or desiccation are performed prior to harvest as an aid in preserving quality and minimizing trash in the harvested cotton.

Chemicals have been widely used as a defoliant; however, the results can be unpredictable and inconsistent. When more than one application is required to obtain satisfactory results timeliness of the harvest operation can be affected and costs increased.

In some areas frost is relied upon to initiate defoliation. This method also has disadvantages, the entire plant can be killed and all growth ceases. This does not allow immature bolls to develop as they would if only the leaves were defoliated and the plant remained alive. The probability of adverse harvesting conditions increases as the season progresses. This type weather could delay harvest and reduce the cotton quality.

Research has shown that the use of heat to accomplish defoliation is feasible, and satisfactory results may be accomplished (1). The application of an optimum amount of heat to a leaf will result in defoliation of that leaf. The defoliation of the leaves does not necessarily indicate that the entire plant is killed. Leaf regrowth may occur sometime after the leaves have been defoliated. Applying an amount of heat, other than the optimum amount, to a leaf may result in desiccation and not necessarily defoliation of that leaf. Partial defoliation or desiccation of leaves may have some advantage. Removal of any of the leaves will aid in harvesting, and desiccation will eliminate leaf stain from the harvested cotton.

Field drying of crops, as thermal defoliation, has been relatively unexplored until recent years. The application of heat to plants as a means of increasing field drying rates may prove to be an economical method of drying. Previous studies have been made concerning the exposure of grain sorghum heads to a direct flame. This study involved subjecting the entire plant to an environment of higher temperature. Grain sorghum and peanuts were used to investigate the possibility of producing an initial moisture content decrease or to increase the drying rate of the plant. This would enable earlier harvest, thereby missing adverse weather conditions and crowded market conditions.

This study involved the design and evaluation of a machine to be used in thermal defoliation of cotton, field drying of grain sorghum, and peanuts. A two-row, self-propelled unit was constructed and operated in mature cotton, grain sorghum, and peanuts under actual pre-harvest conditions.

CHAPTER II

OBJECTIVES

Objectives:

A. Design and construct a thermal defoliation unit which might serve as a prototype for commercial production of thermal applicators for biological material.

B. Evaluate the design by appropriate field and laboratory tests.

C. Determine the versatility of the applicator by studying the performance of this unit on different field crops.

CHAPTER III

REVIEW OF LITERATURE

Previous Thermal Defoliation Equipment

Machines capable of applying heat to several acres per day have not been in existence until only the recent years. One of the earliest thermal defoliation machines to be designed was in 1950 when Nisbet (2) obtained a patent on an apparatus for subjecting cotton plants and the like to hot gases. This machine was suspended behind a row-crop tractor. It consisted of a one-row hood which slid along the ground, a pipe near the front of the hood for an air inlet and a single burner projected into the pipe as a heat source. It is not known if such a device was ever constructed and tested.

The practice of thermally defoliating plants was dropped until 1962 when Batchelder and Porterfield constructed a barrel-type device which heated only single plants. From the results of this device, it was hypothesized that defoliation could be caused by certain combinations of temperature and time of exposure of the plant to that temperature. It was further hypothesized that, as the temperature and/or exposure time were increased, desiccation would result instead of defoliation which is the desired result.

Investigating this hypothesis, a one-row heat hover was constructed in 1963 (4). The hover was a ten-foot sled which was pulled behind a row-crop tractor. There were three burners on each side, arranged vertically. The plants were shielded from coming into direct contact with the flames. This arrangement proved to be unsatisfactory due to the high temperature gradient within the plant. The high temperature air would rise to the top of the plant and kill the leaves, but the lower leaves were not affected.

In 1964, Batchelder and Porterfield (3) introduced the heated air at the bottom of the plant and were able to maintain a fairly uniform temperature throughout the hover. The 1964 machine was a two-row unit mounted under a high-clearance tractor. There were eight burners per row with a single air entrance in the center. The results obtained in the testing of this type of machine were promising. The machine was tested on both dryland and irrigated cotton. In dryland Lankart 57 Cotton, leaf drop as high as 73.0 per cent and leaf kill as high as 99.8 per cent was achieved. In irrigated cotton, leaf drop of 83.4 per cent and leaf kill of 89.0 per cent was obtained. The variables used in their work were temperature and exposure time, and the results collaborate with the hypothesis of 1962. The cost of thermal defoliation was found to be economically feasible (as low as $1.42 per acre for dryland and $0.59 per acre for irrigated), but evaluations had to be made to determine the effects of elevated temperatures on fiber properties. An optimum temperature-time combination needed to be found, and the machine needed to be modified.

In 1965, Batchelder and Porterfield (5) modified the previous machine by placing corrugated metal near the burners to stop buckling of the walls of the machine. A schematic drawing is shown in Figure 1. Self-ignition devices were added to each burner as a safety feature. A heat exchanger was installed and a liquid instead of a vapor fuel

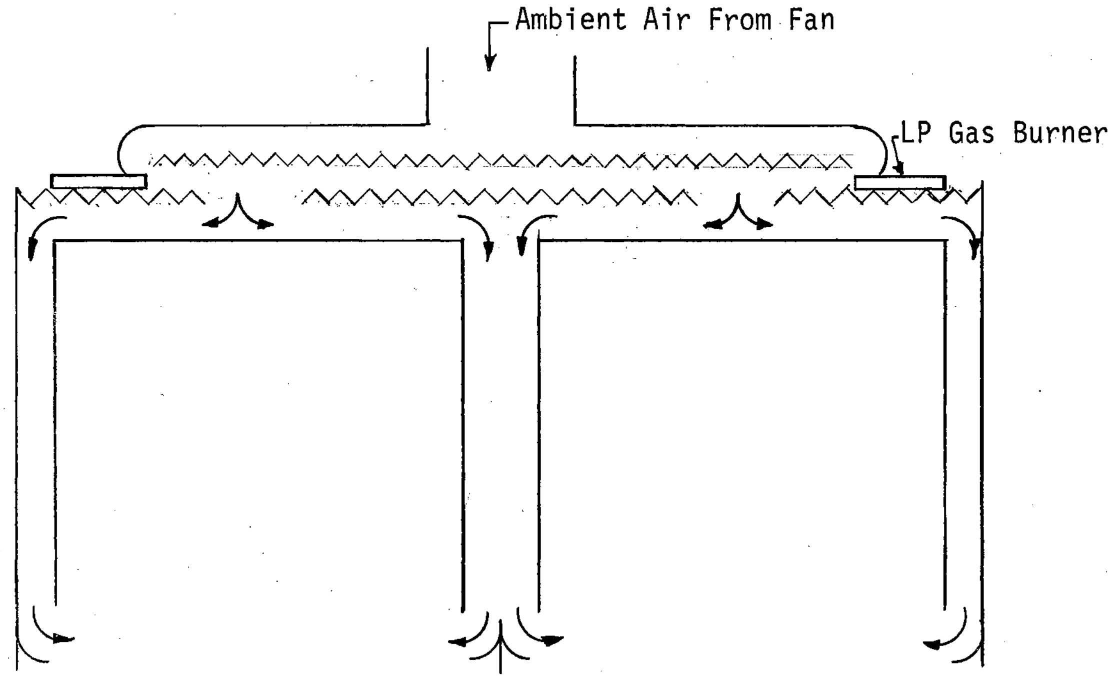

Figure 1. Transverse Cross Section of the 1965 Thermal Defoliator.

withdrawal system was used. The results of 1965 revealed that there was no more damage to the lint than with a chemical defoliant. Testing the machine on irrigated cotton, leaf drop as high as 90.2 per cent and leaf kill as high as 100.0 per cent was obtained. The cost per acre was around two dollars. These were the best results obtained at this time, and it seemed that thermal defoliation would be feasible.

Kent (1) using both the modified 1965 machine and a laboratory apparatus, concluded that:

1. Thermal defoliation of cotton is possible. Cotton plants can be induced to shed their leaves in a predictable manner by subjecting the plant to a super optimal temperature for a short period of time.

2. Temperatures from 400° F to 600° F result in the maximum response. A temperature of 200° F did not result in any significant response.

3. All exposure times studied resulted in significant response depending upon the exposure temperature. In general, an exposure time of two seconds of 500° F resulted in the maximum defoliation, although a unique optimum treatment was not evident from the study.

4. The effect of fan speed variation was not significant in defoliation.

5. The effect of absolute humidity on per cent defoliation and per cent leaf kill was not significant.

6. The defoliation response varies with the time of day. The individual effects of exposure to sunlight, ambient air temperature, and relative humidity were not determined.

7. Field results can be predicted with a limited degree of accuracy from laboratory tests. The correlation coefficient for defoliation was 0.8121 and for leaf kill was 0.9644.

8. Thermal defoliation can be economically competitive with other means of defoliation. Fuel costs for the two-row unit used in this study were on the order of $2 per acre or less for satisfactory defoliation results.

Kent measured his temperatures in the upper center of the hover. Doors were placed in front and back of the machine to try and hold the heat within the hover.

Reifschneider and Nunn (6) used radiant energy to defoliate and desiccate cotton. Perforated tubes with burners in one end were arranged in an inverted U-shape over the cotton plants. Behind each burner was a reflective surface. This converted 50 to 60 per cent of the burner input energy into radiant energy. The reflective surfaces could be changed to several angles. Mechanical and air agitation of the plants were used. The results were as high as 85 per cent leaf kill and 75 per cent drop. Their conclusions were similar to Kent's. They concluded that:

1. Defoliation or desiccation of cotton using infrared radiation is technically feasible.
2. Slightly better defoliation results can be obtained than with chemicals without loss in yield or quality.
3. Radiation intensity and burner length are nearly additive functions.
4. Tilting of the reflector of the side burners at a 45 degree angle to the ground reduces exposure time requirements.
5. Mechanical plant agitation helps.
6. Fuel consumption is economically acceptable.
7. Commercialization will depend on fuel equipment cost.

In 1965, Reifschneider and Nunn (7) modified their hovers. They used a new burner design and a new arrangement. Mesh wire was used to protect the plant from touching the burner. With this new design, a maximum of 92 per cent leaf kill and 75 per cent leaf drop was obtained. This infrared process had no adverse effect on fiber quality. Burner failure was a problem.

The results of Reifschneider and Nunn agree with those of Batchelder and Porterfield in that there is an optimum combination of temperature and exposure time which would cause maximum defoliation.

The writer did not find any information concerning the most desirable configuration of a defoliation unit. Porterfield and Batchelder experienced some boll damage due to the high velocity, high temperature air near the open lower bolls. Reifschneider and Nunn experienced burner failure, and each plant had to be agitated if the radiant energy was to reach each leaf. A new design or a modification of a present design would seem to be desirable if some of the existing problems were to be eliminated.

Previous Field Drying Studies

A limited amount of work has been done concerning field drying of grain sorghum. In 1963, Reece, et al.(8) utilized a small hover over the upper portion of the plant and exposed the heads to a direct flame. They traveled at speeds of 2.3 and 4.6 miles per hour, thereby subjecting the plant heads to temperatures ranging from approximately 2500° F to atmospheric temperature for a very short period of time. This method did cause a significant decrease in moisture content and it increased the drying rate of the sorghum over that which was not treated. Reece, et al., then experimented with application of a chemical (DIQUAT) to the plants. This method also caused a significant increase in the drying rate over that which was not treated.

In 1964, Reece, et al., (9) conducted the same type of research as was conducted in 1963. The results of the 1964 tests agree with those of 1963. Both chemical and flaming increase the drying rate; however, flaming induced more moisture content differences over plants not treated than did chemical. Their conclusion was

> drying of grain sorghum with flame or chemical will significantly increase the field drying of grain prior to harvest. Maximum effect is realized approximately two weeks after treatment. Results suggest that for maximum benefit, treatment should be made near physiological maturity.

In 1963, Parks (10) treated sorghum heads and stalks with flame. Parks found that by subjecting the heads to direct flame the 14 per cent moisture content level could be reached in eight days. Using no treatment, 22 days were required to reach the same point. Complete kill of the plant also showed a significant difference in drying rate, but not as much as flaming in the 20 to 30 per cent moisture content range. In desiccating the plants, Parks subjected the stalks to direct flame thereby stopping all growth. He stated that igniting of the lower dry leaves occurred during desiccation operations.

No information could be found concerning subjecting the head and the stalk to the same high temperature atmosphere. It appears that direct flaming may affect germination of the treated grain. Direct flaming may also affect the quality of the sorghum for livestock feed. It seems that it may be more economical to heat air and then subject the plants to this air. Some of this air might be reused. Rather than expose the head to very high temperatures for a very short period of time, it may be more economical to expose the plants to a less severe temperature for a longer period of time. Less severe temperatures (300 to 600° F) will desiccate a portion of the plant, i.e., desiccate the leaves but not the stalk.

It is not known if simply desiccating the leaves and not the stalk will produce an initial moisture content drop or if it will increase the drying rate. It seems reasonable to assume that, since the leaves are dead and will not require any moisture, then less moisture would enter the plant thereby causing a decrease in grain moisture content; however, the stalk will still contain moisture. This could be the subject of a separate research project.

No information could be found concerning studies involving an increase in the field drying rate of peanuts.

It seems to be the opinion of some (12) (13) that air circulation and direct sunlight are needed for any appreciable field drying to occur. Shepherd (14) concluded that "removal of a portion of the vine tops preparatory to harvesting contributes to machine efficiency and the uniformity of peanut quality in harvesting by the Windrow Method". This portion of vine tops could be removed by use of high temperature air. If field drying rates could be increased, the effects of adverse weather conditions on crop spoilage and the need for excess storage facilities might be eliminated.

CHAPTER IV

DESIGN AND CONSTRUCTION OF THE UNIT

Based upon Kent's (1) and other's (5,6,7) results, thermal defoliation of cotton seemed to be a feasible method of preparing the plants for harvesting. The previous machines seemed to produce desirable results; however, they were largely restricted to research purposes. As was stated in Chapter II, it was the objective of this study to design and construct a machine which would be closer to a production model than previous machines. The problems of machine weight, operating cost, machine complexity and tractor use were examined.

As in previous studies at Oklahoma State University, a Hagie high-clearance tractor was used to propel the unit. It was desired to construct a unit which would not be an integral part of the tractor, as had been previously. This arrangement would allow the operator to use the tractor for other duties, thereby decreasing the machine initial cost.

The amount of material in the unit seemed to be pertinent. This determined the weight and, to a large degree, the cost of the unit. The weight determined the type of soils on which the machine could be used. A heavy, bulky machine was impractical to construct.

A complex machine was also impractical to build. This would increase manufacturing expense.

Since the exposure of the lower open bolls to a high temperature and high velocity air stream caused some boll damage, a different method of air application was desired. It was felt that air could have been directed vertically downward; however, this would have required the burners to have been oriented 90 degrees to the air stream or to have been turned toward the plants. If the high temperature air could be contained within a channel of cooler air, the burners could be oriented parallel to the ground and the contained warm air, rather than the burner, could be turned toward the plants. This idea was confirmed after several preliminary tests. Appendix A contains the results of these tests. These tests revealed that warm air might be contained in an envelope of cooler air; however, these tests were conducted and measurements were made with the air flowing parallel to the ground level. As stated previously, it was desired to turn the contained air downward through the plants. Other preliminary tests were conducted to determine if a high temperature could be maintained on the ground level and to determine if the warm air would still be maintained after being deflected 90 degrees downward. The results of these preliminary tests are included in Appendix B.

It was concluded from these data and figures that it would be possible to orient a burner parallel to the ground, pass cooler air across the burner, deflect the air downward, and maintain an envelope of warm air. This information allowed the unit to be constructed of less material, and a simplified cycling operation was provided for warm air recirculation.

Schematic cross-sections of the final design are shown in Figures 2 and 3. The unit operated on the following principles: Atmospheric air

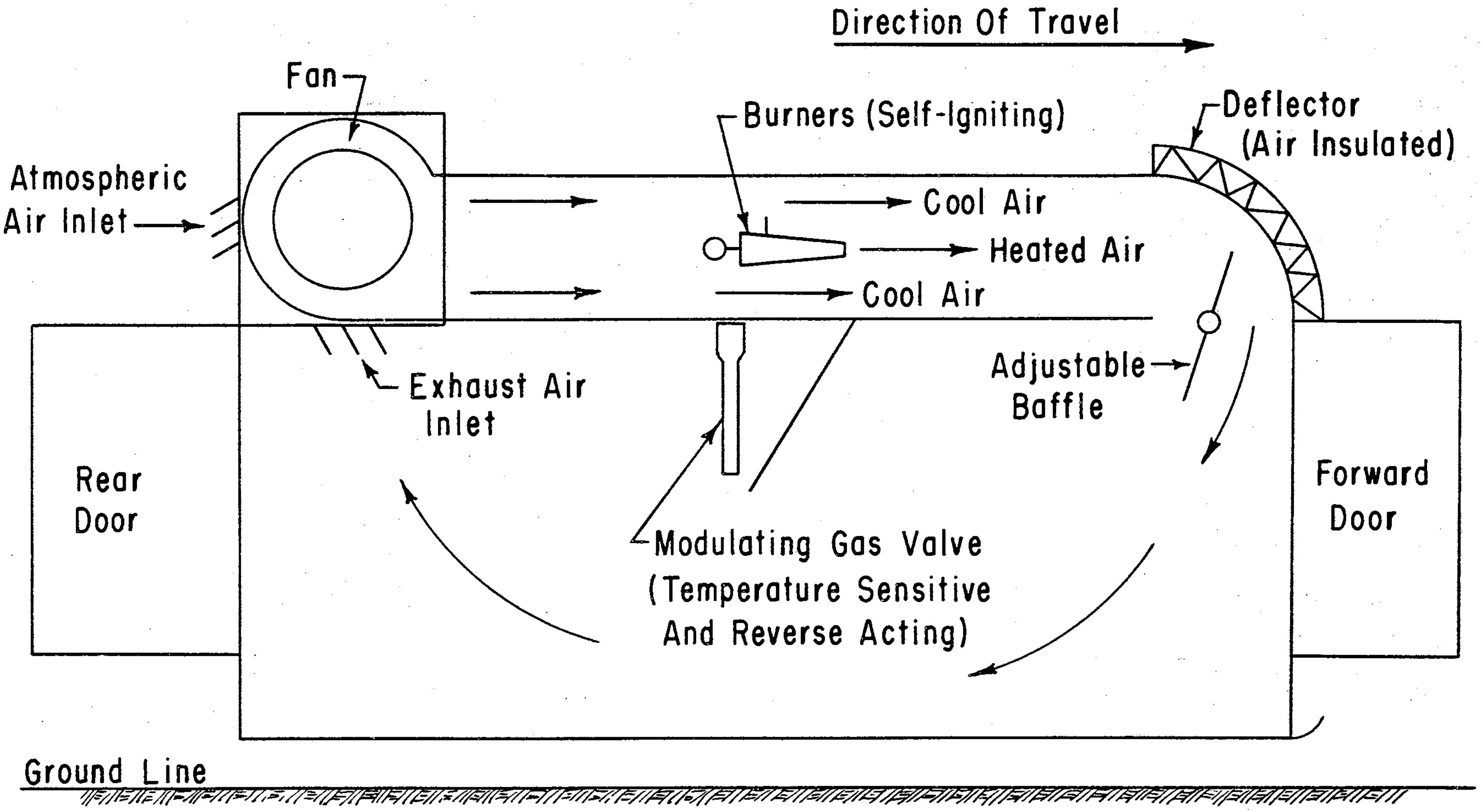

Figure 2. Cross Section of the Thermal Applicator,

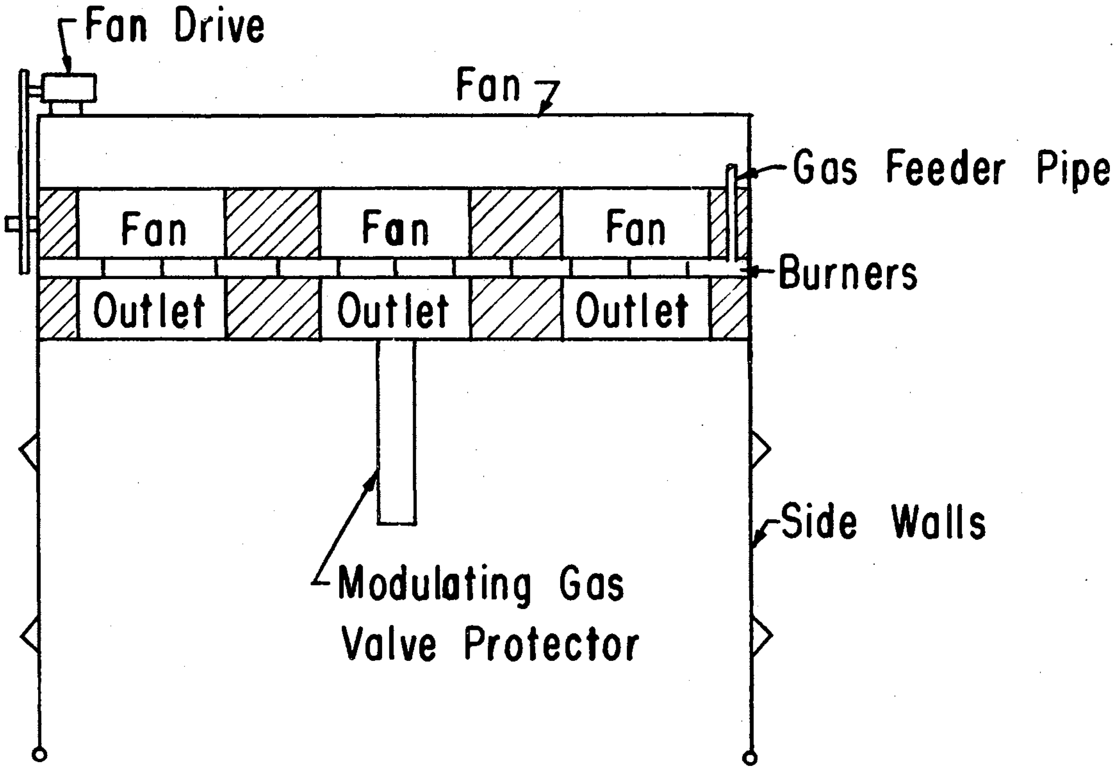

Figure 3. Transverse Cross Section of the Thermal Applicator.

entered the fans (Figure 2) through the damper system. The dampers were adjusted as to the amount of fresh air needed for combustion. As the dampers were closed more exhaust or heated air entered the bottom of the fan. This allowed some of the heated air to be reused. By reusing some of the previously heated air, operating costs were reduced. The air then traveled along a 14 by 80-inch duct and passed over a line of No. 1203 Gotcher burners. There seemed to be three layers of air in front of the burners; a high temperature layer between two low temperature layers. This prevented high thermal stresses within duct walls. The air was then deflected downward by an air-insulated deflector. A baffle was placed at the duct exit to turn the air slightly toward the rear. By using the baffle and the forward motion of the machine, the air moved down and toward the rear rather than down and toward the front. The air then passed through the plant to the ground.

The warm air then began to rise and was picked up by the fan at the rear of the machine. The single thickness walls (Figure 3) served only as a channel for the flowing high temperature air. This eliminated some weight as double walls were previously used (Figure 1). Doors were provided in front and rear to contain the high temperature air. This reduced wind effects and provided an environment of high temperature air. In the center of the hover, near the plants, a temperature sensitive, modulating gas valve regulated the gas flow to the burners. This enabled a constant temperature to be maintained in the hover. As the air temperature decreased, the gas flow to the burners increased. This valve was set for a particular temperature, and it attempted to maintain the air at that temperature.

The three 11-inch diameter centrifugal fans were mounted on a common 1-inch shaft and driven by a hydraulic motor. Figure 4 presents a schematic diagram of the hydraulic system. The hydraulic pump was driven from the front of the tractor engine. A pressure relief valve was installed as a safety device. A two-way valve diverted the flow either to the motor or the supply tank. A flow control valve was installed to divert a portion of the flow to the fan motor. This provided an excellent method for regulating the fan speed.

A burner self-ignition system was installed as a safety device against flameout. Figure 5 presents a schematic diagram of the self-ignition system and a side view of a self-ignition burner. Three magnetos were driven from the rear of the tractor engine. Spark plugs were placed in all of the 13 burners and connected to the magnetos. Valves were placed on individual burners. Ten burners were used during experimentation.

Figure 6 presents the fuel system used in the thermal applicator. A liquid withdrawal system was used. The liquified gas was vaporized previous to combustion. A fast-closing safety valve was installed for the operator to close down the unit rapidly. As previously discussed, a modulating gas valve was installed in an attempt to maintain a constant temperature near the plants.

Ten thermocouples were placed throughout the hover and temperatures were recorded on a strip-chart recorder. Figure 7 presents a schematic representation of the temperature sensing locations and the temperature recording system. The point labeled "A" in Figure 7 is the point at which a constant temperature was attempted to have been maintained during experimental work. The modulating gas valve was located at this point.

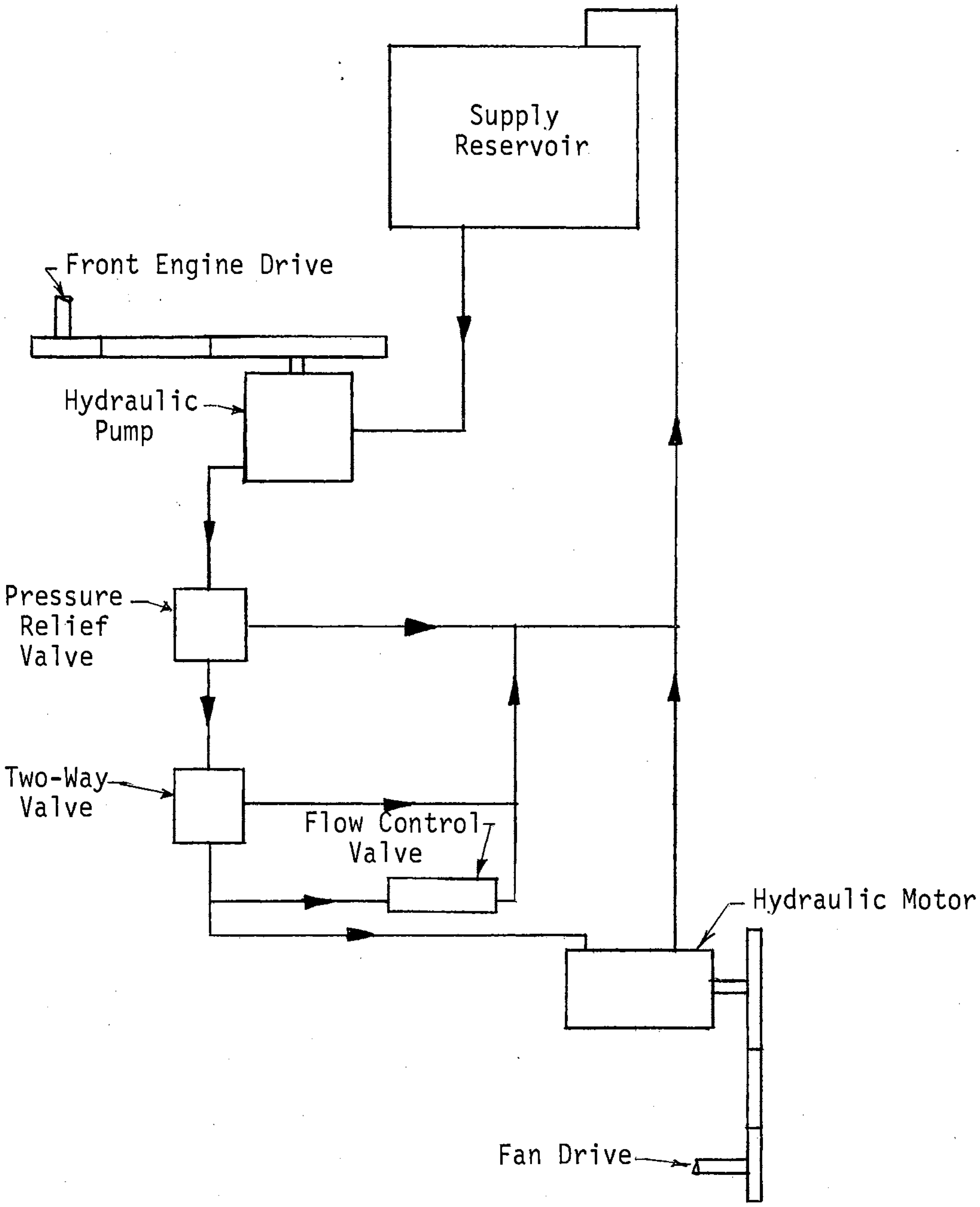

Figure 4. Thermal Applicator Hydraulic System

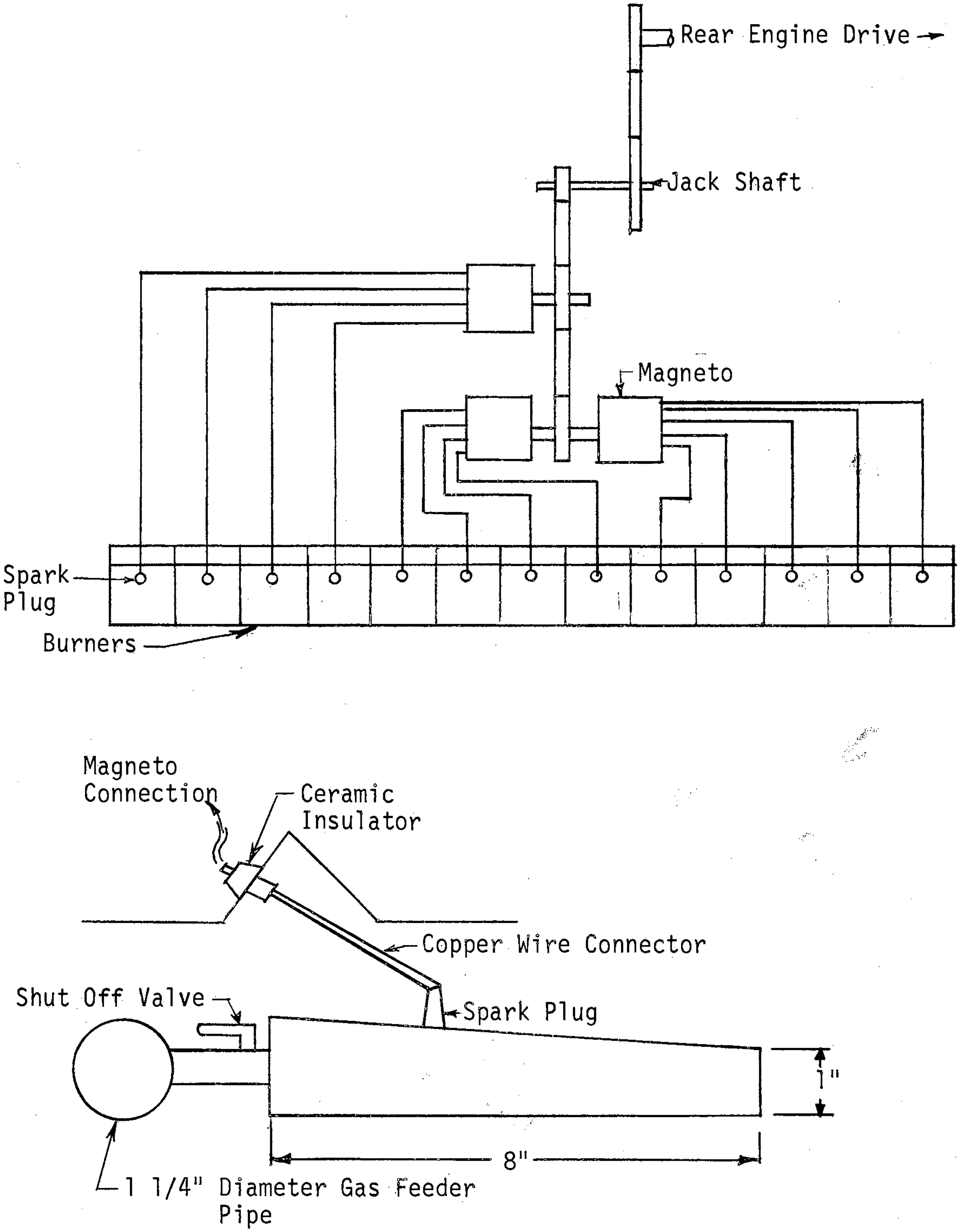

Figure 5. Thermal Applicator Self-Ignition And Burner Operation System.

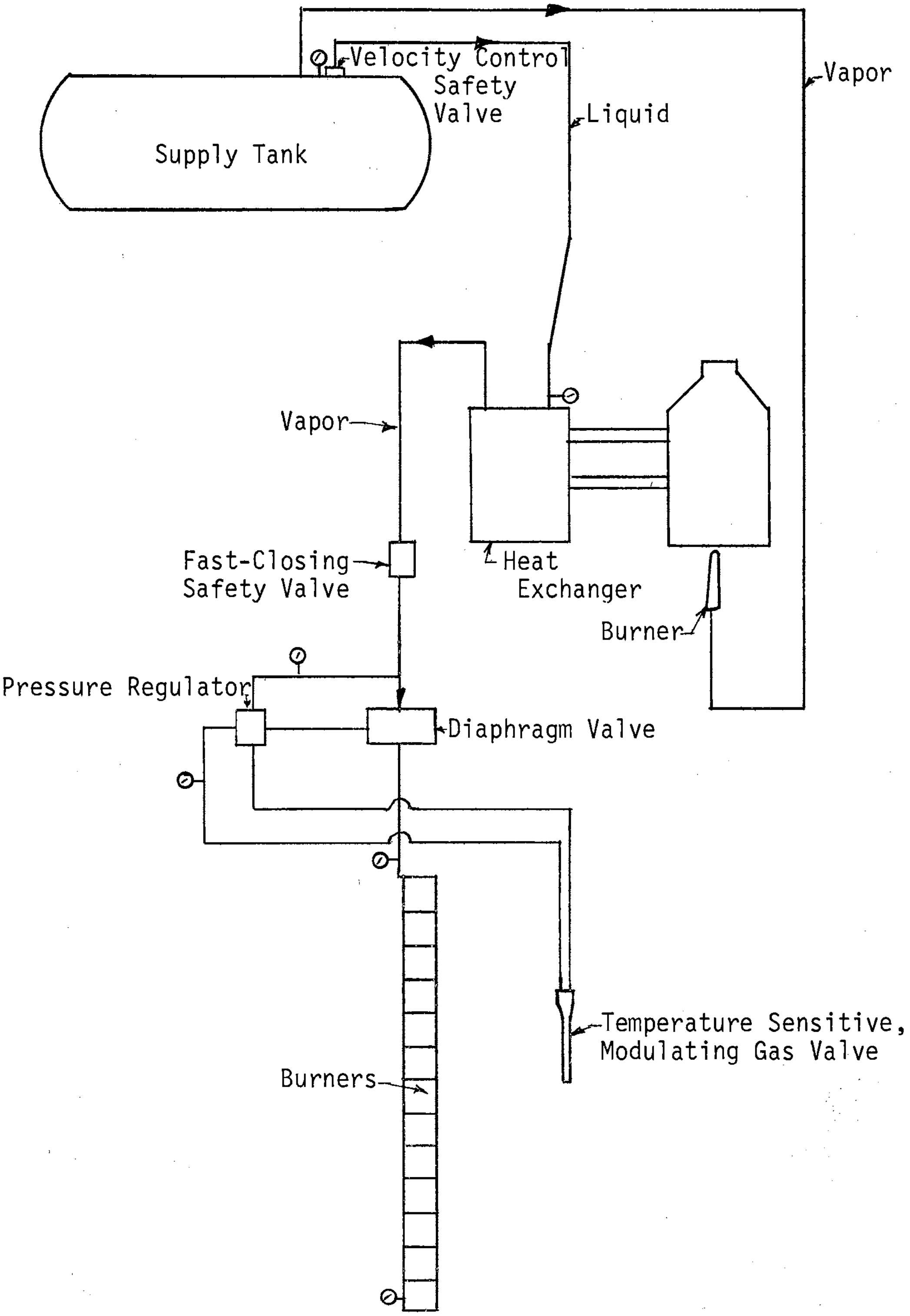

Figure 6. Thermal Applicator Fuel System.

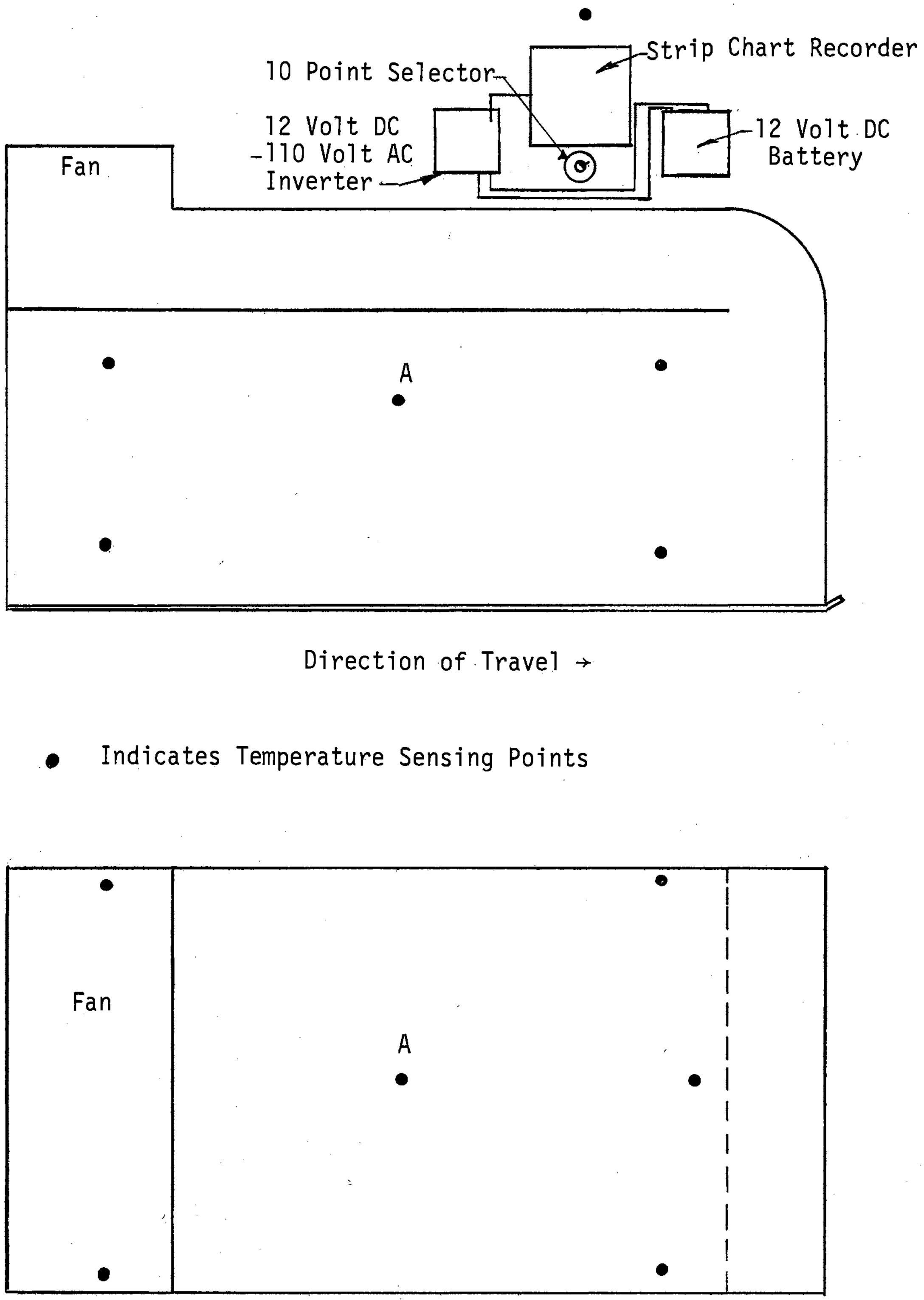

Figure 7. Thermal Applicator Temperature Sensing and Recording System.

The unit was constructed of 26-gauge, galvanized sheet metal and 1-inch square tubing. The tubing wall thickness was 0.140 inches. All tubing joints were welded, and sheet metal joints were either soldered or riveted together. The top, bottom and sides of the air duct were corrugated to allow expansion during heating and to provide rigidity. Figure 8 presents a schematic of the unit. The major dimensions and the corrugation locations are shown. Two corrugations were also placed in the side walls to provide rigidity to the walls. The corrugations were 12 inches apart, with the first being 12 inches from the top of the wall. The side walls were connected in four places along the framework. This allowed the walls to be easily removed and the unit lowered closer to the ground for possible insect or weed control.

Doors were provided in front and rear as an aid in retaining the high temperature air within the hover. Figure 8 presents their principle of operation. As the plants entered the hover, they exerted a force against the spring-loaded doors. The doors opened until the plant was within the hover and then closed. The rear doors opened and then closed as the plants passed outside. This method reduced wind effects and retained heat so that the high temperature air may be reused.

The overall width of the machine was 80 inches. This width was acceptable for a two-row operation; however, commercial units would probably need to include several rows. The overall length of the hover was 8 feet. This length provided an adequate range of exposure times. Thirty-six inches was provided for plant clearance.

The unit was supported at the four corners. Figure 9 presents the supporting mechanisms. Two hydraulic cylinders allowed approximately

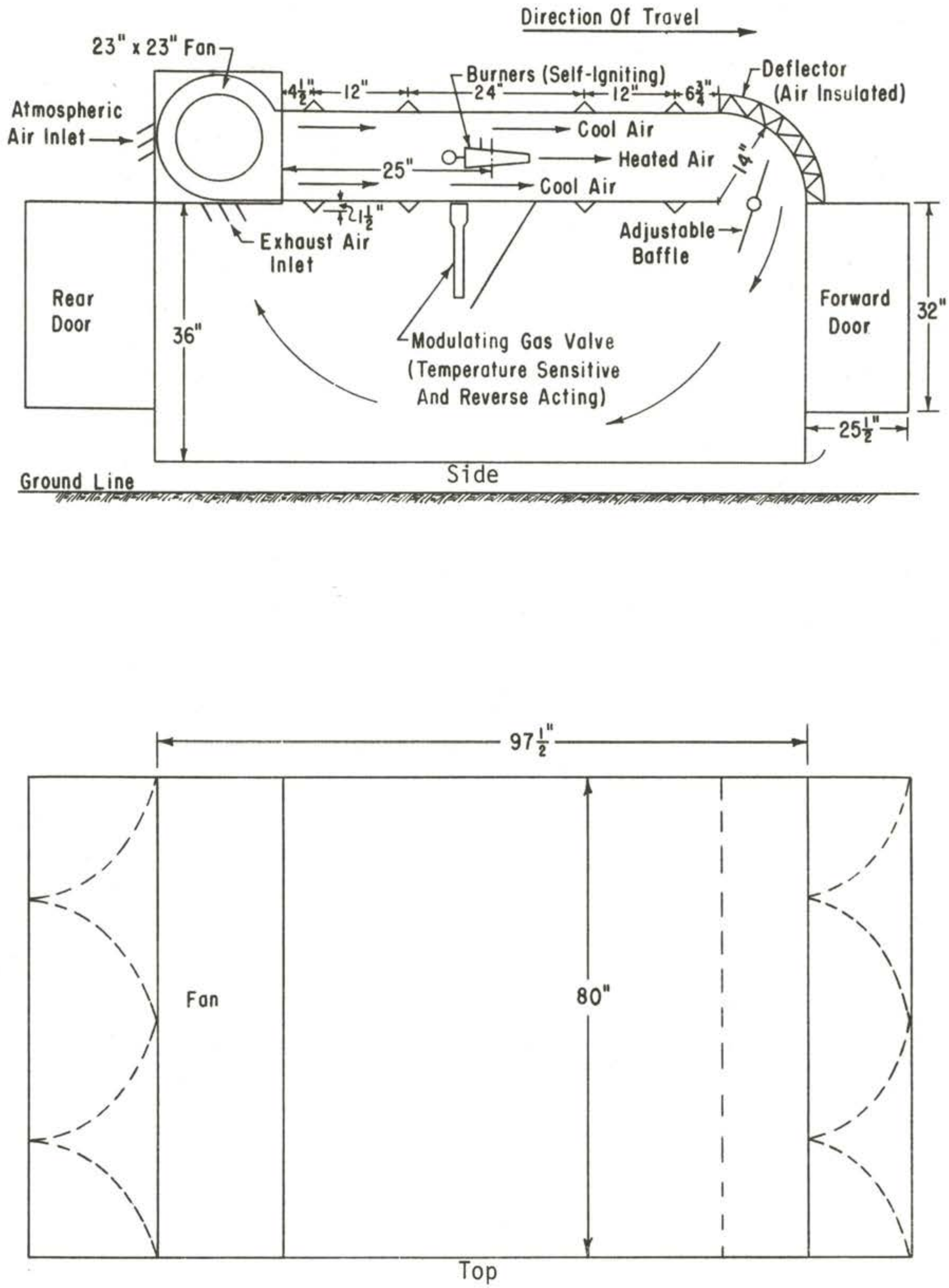

Figure 8. Schematic Side View and Top View of the Thermal Applicator.

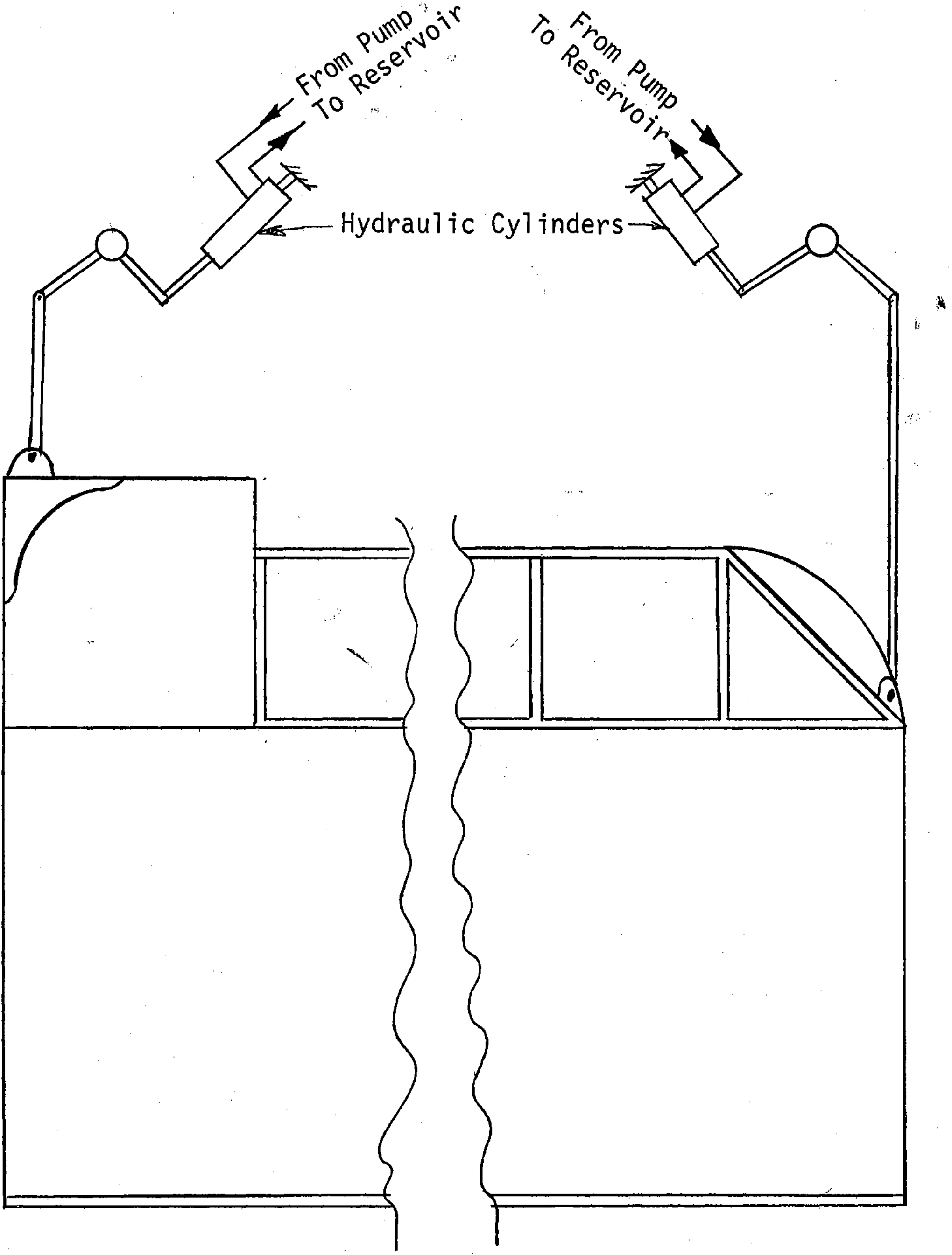

Figure 9. Thermal Applicator Lifting Mechanism.

10 inches lift. This height allowed the machine to travel across the ends of the rows.

Figures 10, 11, 12, and 13 illustrate the assembled field unit.

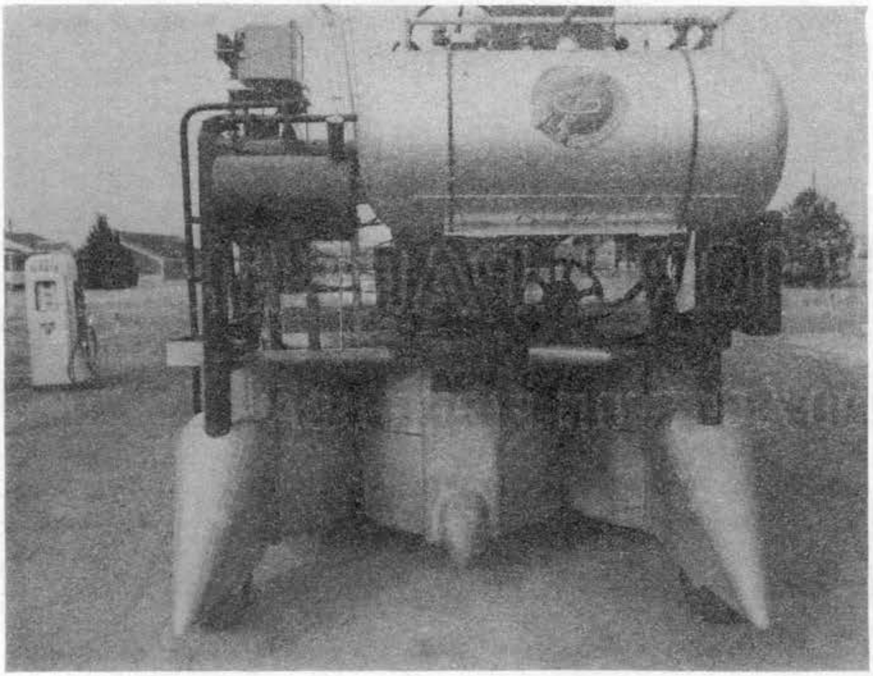

Figure 10. Front View of the Thermal Applicator.

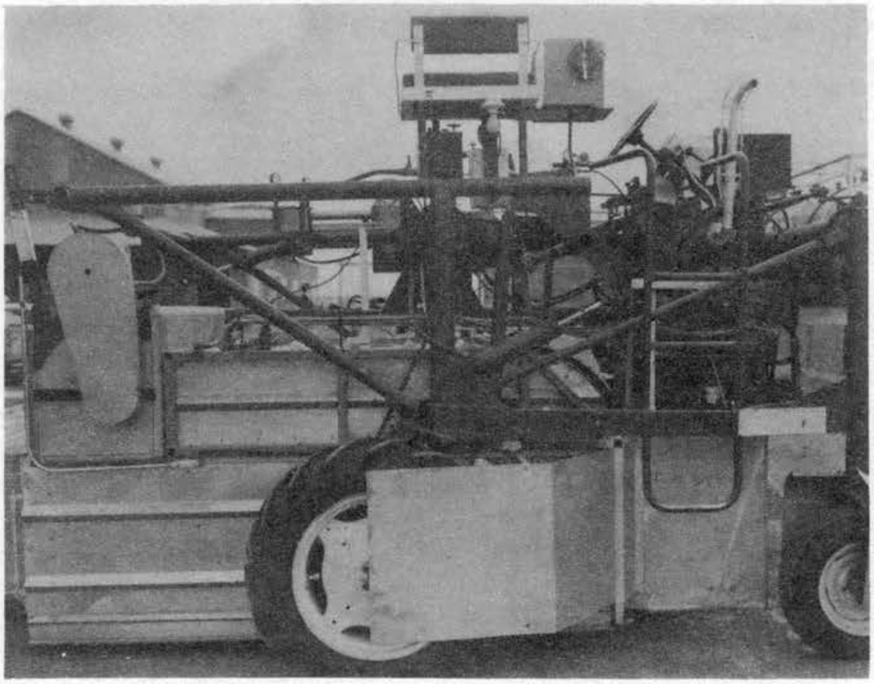

Figure 11. Right Side View of the Thermal Applicator.

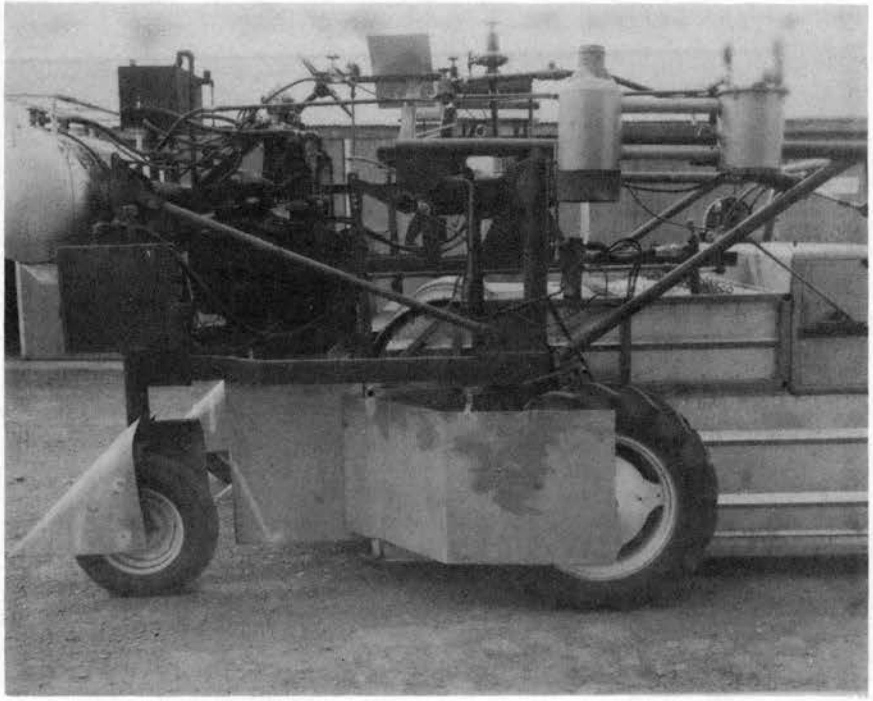

Figure 12. Left Side View of the Thermal Applicator.

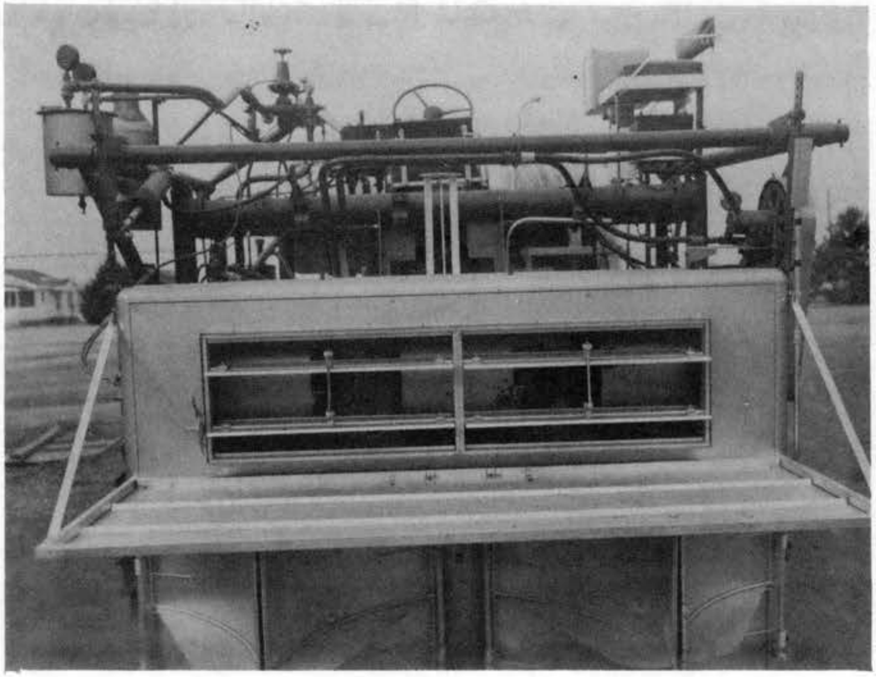

Figure 13. Rear View of the Thermal Applicator.

CHAPTER V

METHODS AND PROCEDURE

After construction of the unit was completed, tests were conducted to determine the air flow pattern across the outlet in the hover. A three-dimensional grid was used to test the velocity at the various points within the hover. The grid spacing was one foot. A hot-wire anemometer and a pitot tube were used to determine the air flow velocity. Velocity measurements were made with the burners off. The equipment available was not calibrated to high temperature air. The measuring devices had to be placed at specific measuring points, and high temperature air made it impossible to relocate the equipment. Three lightweight baffles were placed in the outlet to direct the air stream toward the rear of the machine. A schematic drawing of this arrangement is presented in Figure 14. Table I presents the vertical velocities measured across the outlet. The fan speed used during these preliminary tests was 600 RPM. There was no significant velocity change across the outlet. Table II presents the horizontal velocities within the air duct. Table III presents the vertical velocities across the outlet. Table IV presents the vertical velocities directly below the outlet on the ground level. The fan speed used during these tests was 550 RPM. Table V presents the horizontal velocities within the hover. The fan speed used in these tests was 550 RPM. The lightweight baffles were disfigured by the high temperature air. A

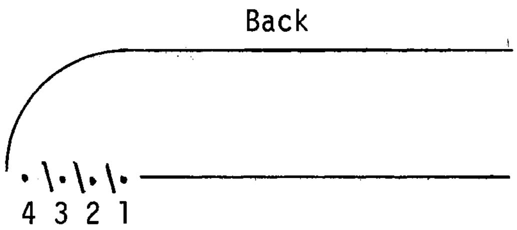

Figure 14. Cross Section of the Arrangement of Light Weight Baffles Used in Air Deflection

TABLE I

VERTICAL VELOCITIES MEASURED ACROSS THE OUTLET

Position											
1	1550	1650	1750	1600	1600	1750	1750	1650	1750	1600	1450
2	1450	1450	1475	1450	1525	1600	1650	1650	1700	1500	1500
3	1450	1550	1525	1575	1775	1600	1650	1700	1750	1500	1500
4	1350	1475	1525	1550	1750	1650	1600	1650	1700	1500	1600

Vertical velocities at the positions indicated in Figure 14 in ft./min. measured every 6 inches across the outlet; fan speed = 600 RPM

TABLE II

HORIZONTAL VELOCITY WITHIN DUCT IN FT./MIN. MEASURED EVERY 6 INCHES ACROSS DUCT

Position in Duct														
Top	300	300	350	450	400	200	100	400	450	400	200	600	500	500
Bottom	1300	1300	1300	1200	1350	1450	1500	1300	1300	1400	1400	1350	1200	1000

TABLE III

VERTICAL VELOCITY AT THE OUTLET IN FT./MIN. MEASURED EVERY 6 INCHES ACROSS THE OUTLET

Position in outlet													
Front	1050	1150	1000	1050	1000	1100	1200	1100	1000	1000	1050	1050	1000
Back	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE IV

VERTICAL VELOCITY DIRECTLY BELOW THE OUTLET ON THE GROUND LEVEL IN FT./MIN. MEASURED EVERY 6 INCHES ACROSS THE OUTLET

Position														
Directly below outlet front	500	450	450	400	400	500	200	350	400	450	500	500	600	600

TABLE V

HORIZONTAL VELOCITIES IN FT./MIN. WITHIN THE HOVER

(Measurements were made in 1 foot intervals)

				Front		
Outlet	40	40	55	60	60	Floor
1'	95	90	85	90	85	
2'	190	110	70	95	105	
3'	325	195	150	175	210	
4'	550	450	300	225	325	

				Front		
Outlet	50	45	65	90	80	1 ft. off Floor
1'	240	55	250	55	85	
2'	550	240	375	160	170	
3'	375	330	400	550	700	
4'	550	575	525	625	650	

				Front		
	1	2	3	4	5	
Outlet	85	37	30	35	60	2 ft. off Floor
1'	550	175	500	125	275	
2'	975	925	775	825	900	
3'	220	375	675	425	200	
4'	140	190	250	300	170	

heavier single baffle was installed. Table VI presents the vertical velocities measured at the points indicated in Figure 14 using the single baffle. Table VII presents the horizontal velocities obtained within the hover using the single baffle. The fan speed used during these tests was 600 RPM. These tests revealed that there was no significant variation of air velocity across the outlet or the hover.

Preliminary investigations revealed that higher temperatures were being obtained on the left side of the machine than on the right side of the machine. A damper was placed on the left fan and the air flow reduced. Measurements and preliminary defoliation tests indicated that a uniform temperature distribution did exist across the hover.

The machine was designed primarily for use in defoliation of cotton although tests were made on other crops.

A thorough experiment schedule was designed for cotton; however, this was shortened due to adverse weather conditions.

A treatment with the unit consisted of a combination of forward speed, air temperature, and fan speed. The forward speed was measured with a conventional speedometer on the machine. The air temperature was measured in the center of the hover using a thermocouple. The temperature was measured approximately 20 inches above the ground surface. The fan speed was measured with a tachometer mounted near the operator and connected to the fan shaft by use of a flexible cable. Air temperature was controlled by burner regulation, and the fan speed was controlled by a hydraulic flow control valve.

Twenty-seven treatments were applied to cotton. Air temperature, exposure time and air velocity were considered to be pertinent factors. Air temperatures of 300, 400, 500 and 600 degrees Fahrenheit were used.

TABLE VI

VERTICAL VELOCITIES AT THE POSITIONS INDICATED IN FIGURE 14 MEASURED EVERY 6 INCHES ACROSS THE OUTLET

(Fan speed = 600 RPM. A single, heavy baffle was used during velocity measurements.)

Position											
1	1450	800	1400	1450	1400	1400	1400	1450	1350	1100	1300
2	1400	1400	1400	1400	1400	1400	1400	1400	1400	1450	1350
3	1400	800	300	250	225	250	275	300	325	500	500
4	400	375	300	300	250	300	300	300	350	350	425

TABLE VII

HORIZONTAL VELOCITIES OBTAINED WITHIN THE HOVER IN FT./MIN.

(Measurements were made in 1-foot intervals)

				Front		
	1	2	3	4	5	
Outlet	350	350	325	325	350	
1	325	325	350	325	325	
2	425	400	375	425	450	Floor
3	425	400	375	425	425	
4	360	350	330	340	360	

				Front		
	1	2	3	4	5	
Outlet	780	1000	300	700	600	
1	1100	700	850	1000	1400	
2	150	200	150	200	150	1 ft. from Floor
3	150	190	200	170	80	
4	170	260	250	200	180	

Fan speeds of 400 and 700 revolutions per minute were used. Relative humidity was ignored because Kent (1) did not find that it was pertinent and Went (11) states that relative humidity has no effect on plant growth or fruition. Temperature control was most important in his tests. Production was doubled under controlled temperature conditions.

Leaves were counted 13 days after treatment. The variety of irrigated cotton used was Lankart 57. The planting date was May 18, 1966. The cotton was treated on October 7, 1966. The per cent defoliated and desiccated was then calculated. The formulas used in these calculations are shown below:

Per Cent Defoliated = ((No. Leaves Before Treatment - No. Leaves After Treatment)/No. Leaves Before Treatment)(100)

Per Cent Desiccated = ((No. Leaves Before Treatment + No. Dead Leaves - No. Leaves After Treatment)/ No. Leaves Before Treatment)(100)

Eight plants per treatment were selected at random and calculations were made on these plants. It was assumed that there was no significant differences in the cotton quality, yield, or uniformity across rows or along rows. Boll damage was checked on the treatments. Ten-foot sections of the treatments were randomly selected. The number of tinged or burned bolls was recorded 13 days after treatment.

No design changes were made on the unit in treating grain sorghum. Forward speed, air temperature, and fan RPM were measured as they were in the treatment of cotton. Eight treatments with two replications were applied to the grain. Air temperatures of 400, 500, and 600 degrees Fahrenheit were used. Forward speeds of 1, 1 1/2, 2, and 3 MPH were used. The only fan speed used on the sorghum was 700 RPM. Sampling heads were selected randomly before treatment and marked for later sampling. A sample consisted of taking an entire head and removing the grain along with the small stems. The grain was then placed in a container and sealed. This procedure was to prevent loss of moisture from the field to the drier. Each sample was then weighed and placed in a drying oven at 212 degrees Fahrenheit for a 24-hour period. The samples were then weighed again and the moisture content was calculated on a wet basis. The formula used in moisture content calculation is as follows:

$$\text{Per Cent Moisture Content} = [(\text{Wt. Grain} + \text{Wt. Water} - \text{Wt. Grain})/(\text{Wt. Grain} + \text{Wt. Water})](100)$$

Samples were taken immediately prior to treatment, immediately after treatment, two hours after treatment, one day after treatment and every other day thereafter for a period of 15 days after treatment. The sorghum variety used was OK-612. The planting date was May 27, 1966. Treatments were applied September 13, 1966.

Peanuts were also treated with the unit as it was used on cotton. Variables were measured as they were in the two previous tests. Seven treatments were applied to peanuts with two replications. A severe heat treatment (air temperature = 600° F, forward speed = 1 MPH, fan speed = 700 RPM), a light heat treatment (air temperature = 400° F, forward speed = 3 MPH, fan speed = 700 RPM), and two check plots were the treatments. One check plot was dug and the other was not. The objective of the light heat treatment was to defoliate the leaves only. It was desired to keep the plant alive. The objective of the severe heat treatment was to kill both leaves and plants. Two digging dates were selected. A sample consisted of removing the developed peanuts from a randomly selected plant. A developed peanut was defined as one which would probably be chosen during harvest as edible after some drying. The peanuts were placed in a container and sealed. Each sample was weighed and then placed in a drying oven at 212 degrees Fahrenheit for a 24-hour period. Each sample was then weighed again and the moisture content was calculated on a wet basis. Samples were taken before treatment, immediately after treatment, one day after treatment, and every other day thereafter for a period of one week. Three randomly selected samples were taken from each plot. The objective of these tests was to determine if, by using the designed unit, the drying rate of peanuts could be increased in the field. The observation was made that with higher levels of heat treatments the leaves became lighter in color. With the light heat treatment, the leaves became very dark soon after treatment. The severe heat treatment showed little or no discoloring effect.

The variety of the peanuts treated was the Star variety. The planting date was June 7, 1966. Treatments were applied September 29, 1966.

CHAPTER VI

PRESENTATION AND ANALYSIS OF DATA

Cotton Studies

The per cent defoliated and the per cent desiccated was calculated for each cotton plant. The average defoliation and desiccation was then calculated for each treatment. These data are presented in Appendix C-I. This experiment was considered to be a 3 x 4 x 2 factorial design. Appendix C-II presents a defoliation analysis of variance. A significant difference between treatments was found. Table VIII presents a Duncan's Multiple Range test of significant differences for the defoliation treatment means. Treatments enclosed by a continuous line represent no significant difference among those particular means. Air temperature, ground speed and the interaction of air temperature and ground speed were found to be significant in cotton defoliation. The remainder term also appeared as significant. This term contained three degrees of freedom. One degree of freedom being the 600 degree Fahrenheit treatments versus all of the other treatments and the other two degrees of freedom are found in the three forward speeds used in the 600 degree Fahrenheit treatments. It could be that there is a significant difference between the 600 degree Fahrenheit treatments and all of the other treatments or there is a significant difference among 600 degree Fahrenheit treatments.

TABLE VIII

DUNCAN'S MULTIPLE RANGE TEST OF SIGNIFICANT DIFFERENCES OF COTTON DEFOLIATION TREATMENT MEANS

$\alpha = 0.05$

Trt. Mean	Air Temp. °F	Treatment Forward Speed MPH	Fan Speed RPM
6.54	600	4	700
10.39	400	4	400
13.03	500	4	400
13.28	500	3	400
13.98	400	4	700
14.13	300	4	400
14.21	300	3	700
15.32	500	3	700
19.18	300	4	700
19.23	500	4	700
21.97	400	3	400
26.36	400	3	700
27.01	300	3	400
29.81	400	2	400
29.85	300	1	700
32.07	300	2	700
32.43	300	2	400
32.74	400	2	700
36.78	600	3	700
40.08	300	1	400
45.11	500	2	400
54.93	500	2	700
68.34	400	1	400
77.37	600	2	700
78.42	400	1	700
85.02	500	1	700
87.35	500	1	400

Appendix C-III presents a desiccation analysis of variance. A significant difference was found among treatments. Table IX presents a Duncan's Multiple Range test of significant difference for the desiccation treatment means. Treatments enclosed by a continuous line represent no significant difference among those particular means. Air temperature, ground speed, fan speed, the interaction of air temperature and ground speed, the interaction of air temperature and fan speed, the interaction of air temperature and ground speed and fan speed, and the remainder term were found to be significant in leaf desiccation.

Boll damage is recorded in Appendix C-I. Ten foot sections of the plots were chosen randomly. The values recorded are the number of damaged (tinged or burned) bolls over the number of bolls counted. All treatments were not counted. The more severe treatments were counted first; and, if no damage due to high temperature air was found, the less severe treatments were not counted. Boll damage was insignificant. Three damaged bolls in 88 counted was the largest number found in the tests.

Response surfaces were developed for defoliation and desiccation. A prediction equation describing the data was found. An equation of the following form was used:

$$Y = C_0 + C_1X_1 + C_2X_1^2 + C_3X_2 + C_4X_2^2 + C_5X_1X_2 + C_6X_1X_2^2 + C_7X_1^2X_2 + C_8X_1^2X_2^2$$

where

Y = Per cent defoliated or desiccated

X_1 = Air temperature - ° Fahrenheit $(X\ 10^2)$

TABLE IX

DUNCAN'S MULTIPLE RANGE TEST OF SIGNIFICANT DIFFERENCES OF COTTON DESICCATION TREATMENT MEANS

$\alpha = 0.05$

Trt. Mean	Air Temp. °F	Treatment Forward Speed MPH	Fan Speed RPM
14.21	300	3	700
17.23	400	4	700
19.18	300	4	700
20.50	500	3	400
20.67	500	4	400
20.81	400	4	400
26.67	500	4	700
26.71	400	3	400
27.05	300	4	400
29.52	600	4	700
32.78	400	3	700
32.79	300	3	400
33.58	300	2	700
37.32	300	2	400
38.44	400	2	400
47.06	300	1	400
68.81	300	1	700
76.45	600	3	700
77.15	500	3	700
80.13	400	2	700
81.84	500	2	400
89.70	500	2	700
93.97	400	1	400
98.88	400	1	700
98.95	600	2	700
99.42	500	1	400
100.00	500	1	700

X_2 = Exposure time - seconds

C_i = Coefficients under given conditions

This equation was used by Kent (1) and a comparison of coefficients could easily be found by use of the above equation. Using all data (both fan speeds) the coefficients were found and are presented in Table X.

Figures 15 and 16, respectively, are the response surfaces for defoliation and desiccation. The change in the average per cent defoliation as a function of air temperature and exposure time is shown in Figure 15. The change in the average per cent desiccation as a function of air temperature and exposure time is shown in Figure 16.

The following observation was made concerning the variation of coefficients recorded in Table X. Kent (1) measured the air temperature near the center of the plant and near the top of the hover. The air temperature in this study was measured near the center of the row and near the center of the hover. Only one fan was used in the previous study, whereas three fans were used in this study. The amount of high temperature air moved by the different fans might have made a difference in the coefficients. The configuration of the two machines was different. The air application was from the top of the plant in this study and from the bottom of the plant in the previous studies. A combination of machine design changes, air temperature measurement location change and air velocity measurement location change may have varied the coefficients. The data in both cases fits the equation with reasonable accuracy, indicating similarity of results.

TABLE X

COMPARISON OF PREDICTION EQUATION COEFFICIENTS FOR 1965 AND 1966 THERMAL DEFOLIATION AND DESICCATION RESULTS

	Defoliation			Desiccation	
	Perry	Kent		Perry	Kent
C_0	-231.3343	134.5056	C_0	240.7984	148.7021
C_1	129.1950	67.1382	C_1	- 99.1216	- 68.8525
C_2	- 18.2313	10.8384	C_2	7.2955	9.7349
C_3	244.9929	- 95.4764	C_3	-123.7366	-105.2430
C_4	- 44.8489	13.7221	C_4	5.0066	16.3103
C_5	-126.1766	64.9321	C_5	48.6408	63.1543
C_6	23.0094	- 8.6464	C_6	0.1482	- 8.8021
C_7	17.1474	- 9.0569	C_7	- 1.4551	- 7.3993
C_8	- 2.9500	1.1647	C_8	- 0.6088	0.0881
Correlation Coefficient	0.9794	0.9474		0.9348	0.9953

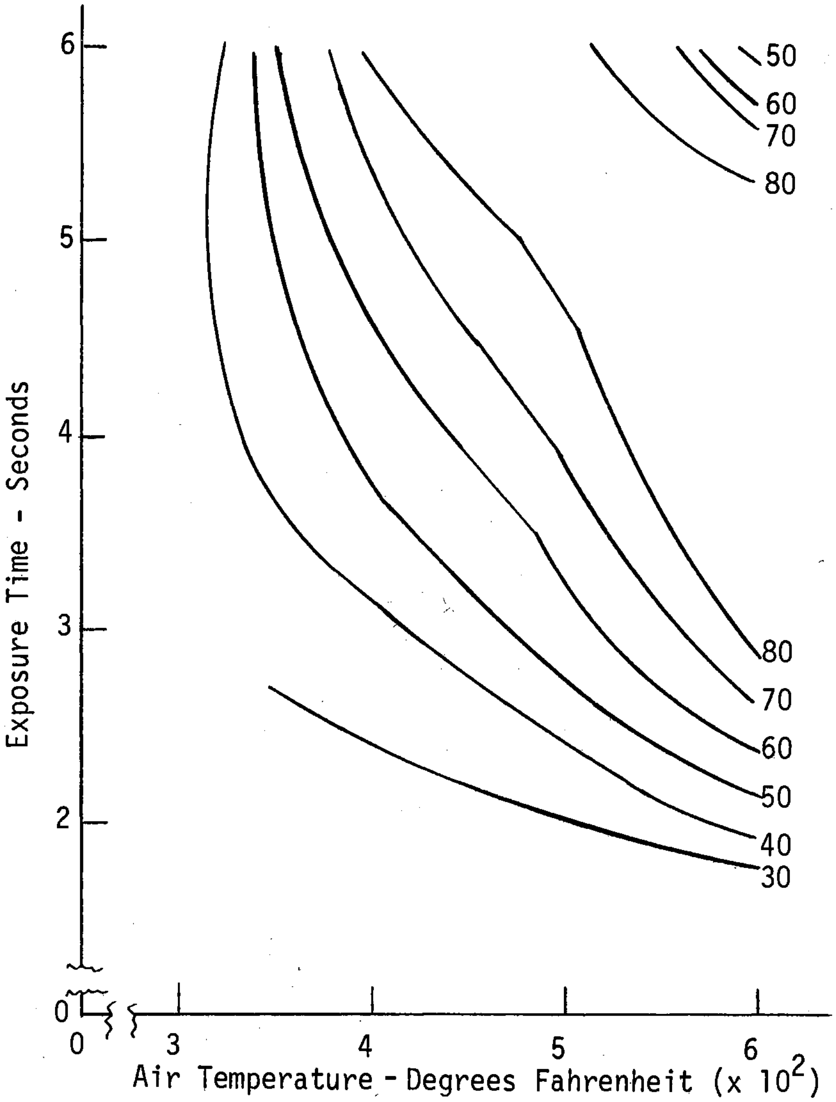

Figure 15. Per Cent Defoliation as a Function of Air Temperature and Exposure Time.

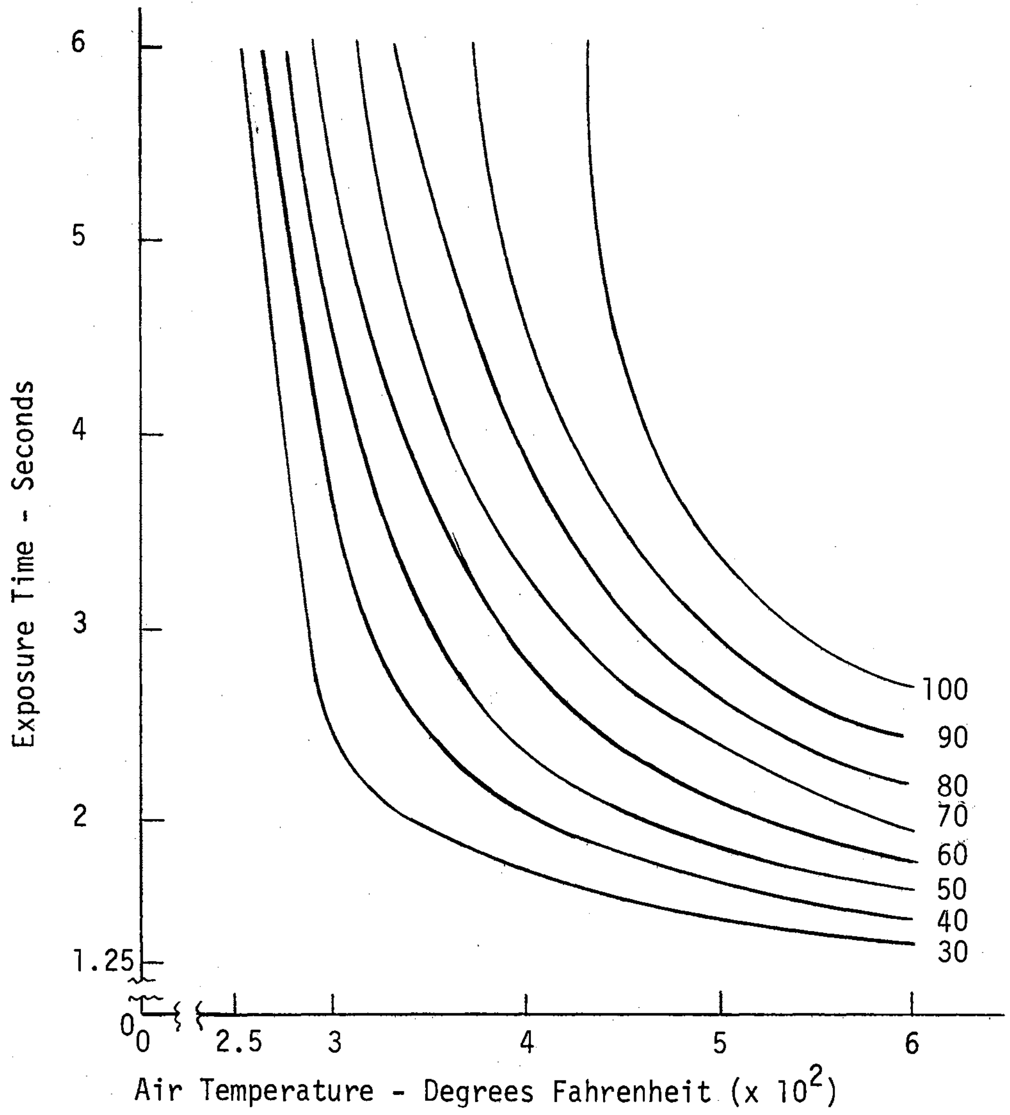

Figure 16. Per Cent Desiccation as a Function of Air Temperature and Exposure Time

Grain Sorghum Studies

The grain sorghum experiment was considered as a randomized block design. Appendix D-I presents the field data collected. Two separate tests were conducted on the sorghum. The first was a test in which the entire head of each plant was taken and tested. The other test was conducted with the objective being to reduce the variability among samples. Heads were chosen and tagged for future sampling. A small portion of each head was taken for each sample. This procedure did not significantly reduce the variability; therefore, these data are not presented in this report. Appendix D-II presents the analysis of variance for grain sorghum. It was found that the sampling error mean square and the experimental error mean square were estimating the same thing; therefore, the two mean squares may be pooled. The design was blocked with time as it was assumed that there would be a change across time. There was a significant difference in treatments and a significant change across time.

Table XI presents a Duncan's Multiple Range test of significant differences for the grain sorghum treatments. Treatments enclosed by a continuous line represent no significant difference among those particular means. Figures 17, 18, 19, 20, 21, 22, and 23 illustrate that all treatments increased the drying rate over the 20-day period. These figures are graphs of per cent of the original moisture content versus time. These figures are presented to indicate the drying rate of all treatments and as a means of comparing moisture reduction of treatments after a given time period. Interpretation of the figures is illustrated in Figure 18. Thirteen days after treatment, the grain sorghum in the check plot contained 48.2 per cent of the original

TABLE XI

DUNCAN'S MULTIPLE RANGE TEST OF SIGNIFICANT DIFFERENCES FOR GRAIN SORGHUM TREATMENT MEANS

$\alpha = 0.05$

	Treatment	
Trt. Mean	Air Temp °F	Forward Speed MPH
14.830	600	2
15.101	400	1
15.589	400	1½
15.628	600	1
15.679	500	1
16.255	600	3
16.336	500	2
16.885	Ambient	

Treatment means listed are per cent moisture content (wet basis).

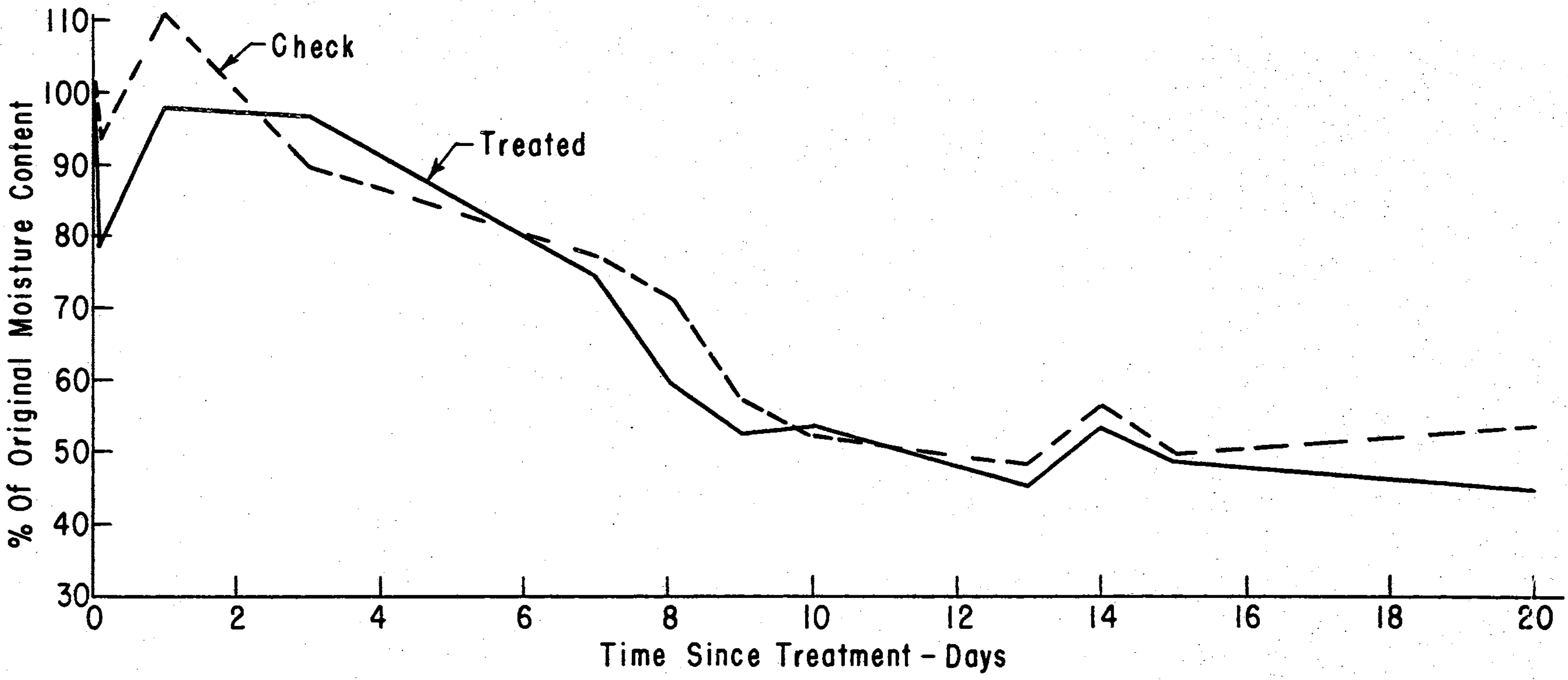

Figure 17. Per Cent of Original Moisture Content of Grain Sorghum Versus Time Since Treatment for 400° F Air and 5.45 Seconds (1 MPH) Exposure Time.

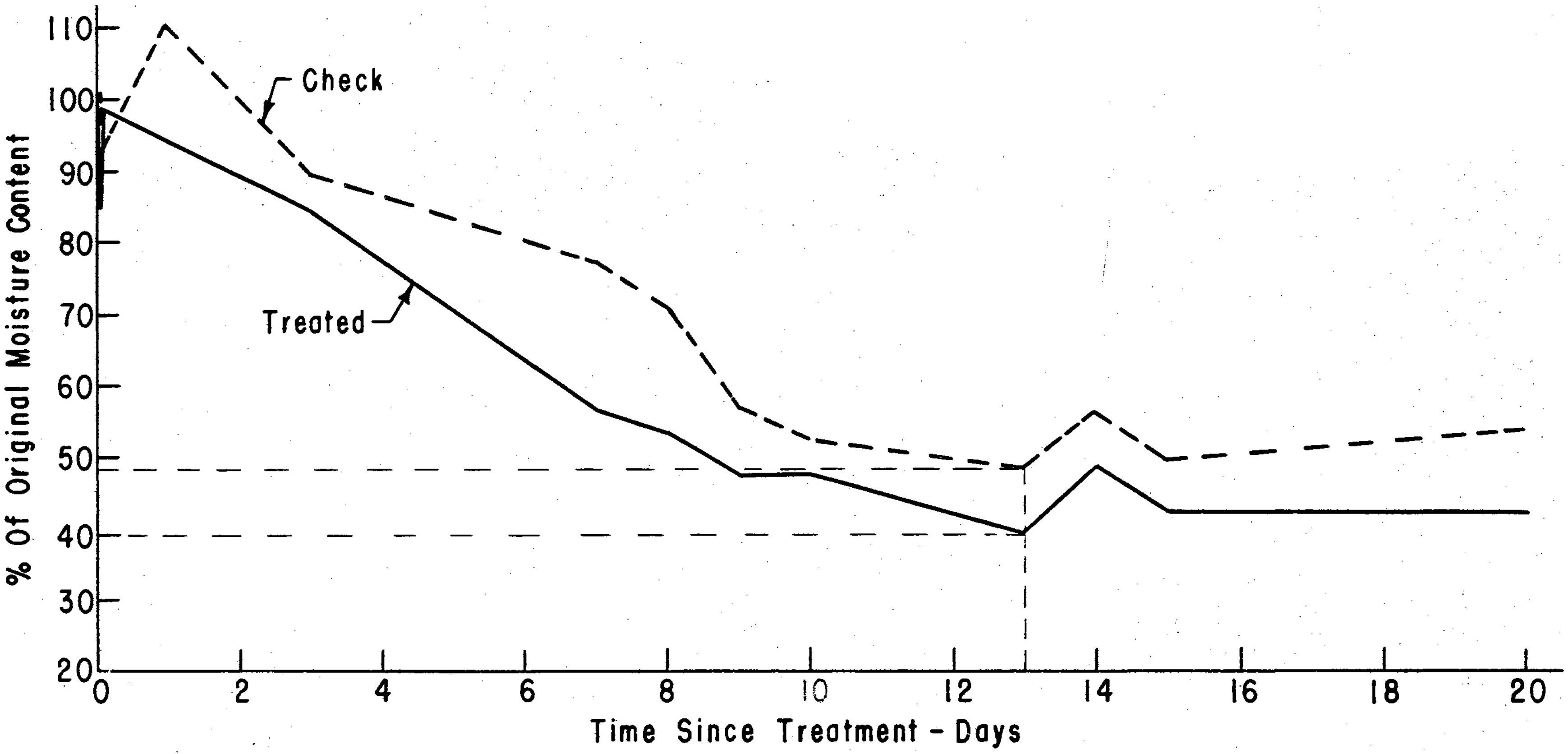

Figure 18. Per Cent of Original Moisture Content of Grain Sorghum Versus Time Since Treatment for 400° F Air and 3.638 Seconds (1 1/2 MPH) Exposure Time.

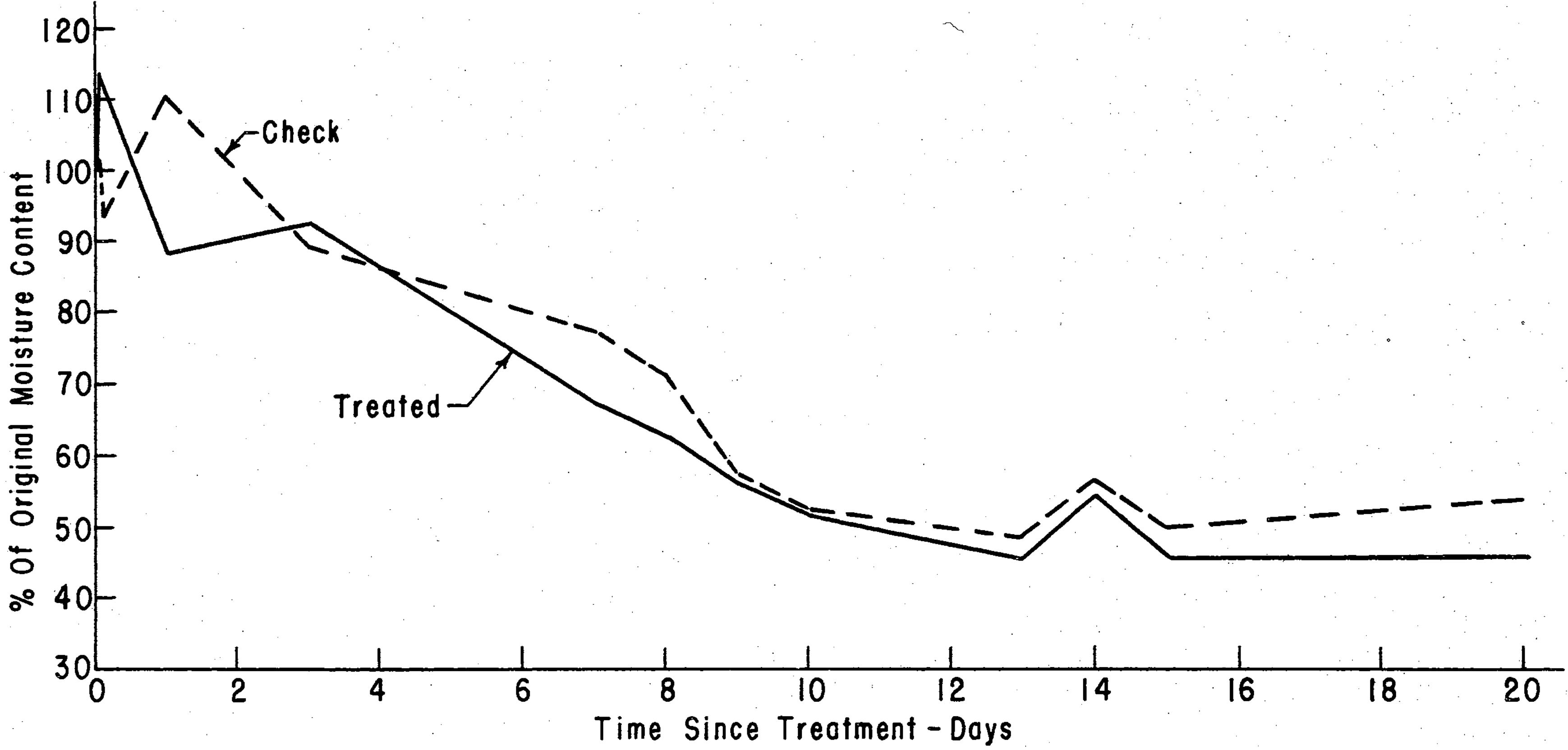

Figure 19. Per Cent of Original Moisture Content of Grain Sorghum Versus Time Since Treatment for 500° F Air and 5.45 Seconds (1 MPH) Exposure Time.

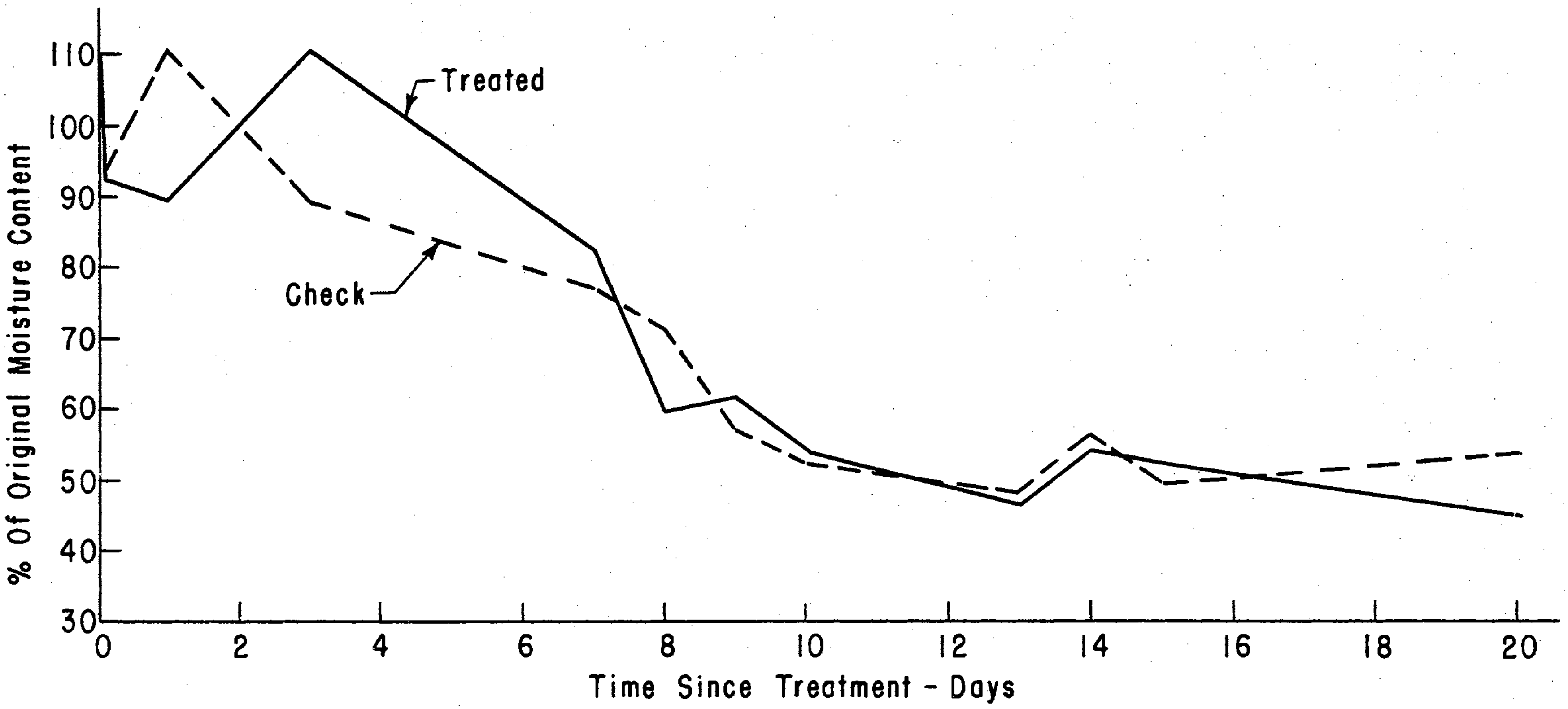

Figure 20. Per Cent of Original Moisture Content of Grain Sorghum Versus Time Since Treatment for 500° F Air and 2.73 Seconds (2 MPH) Exposure Time.

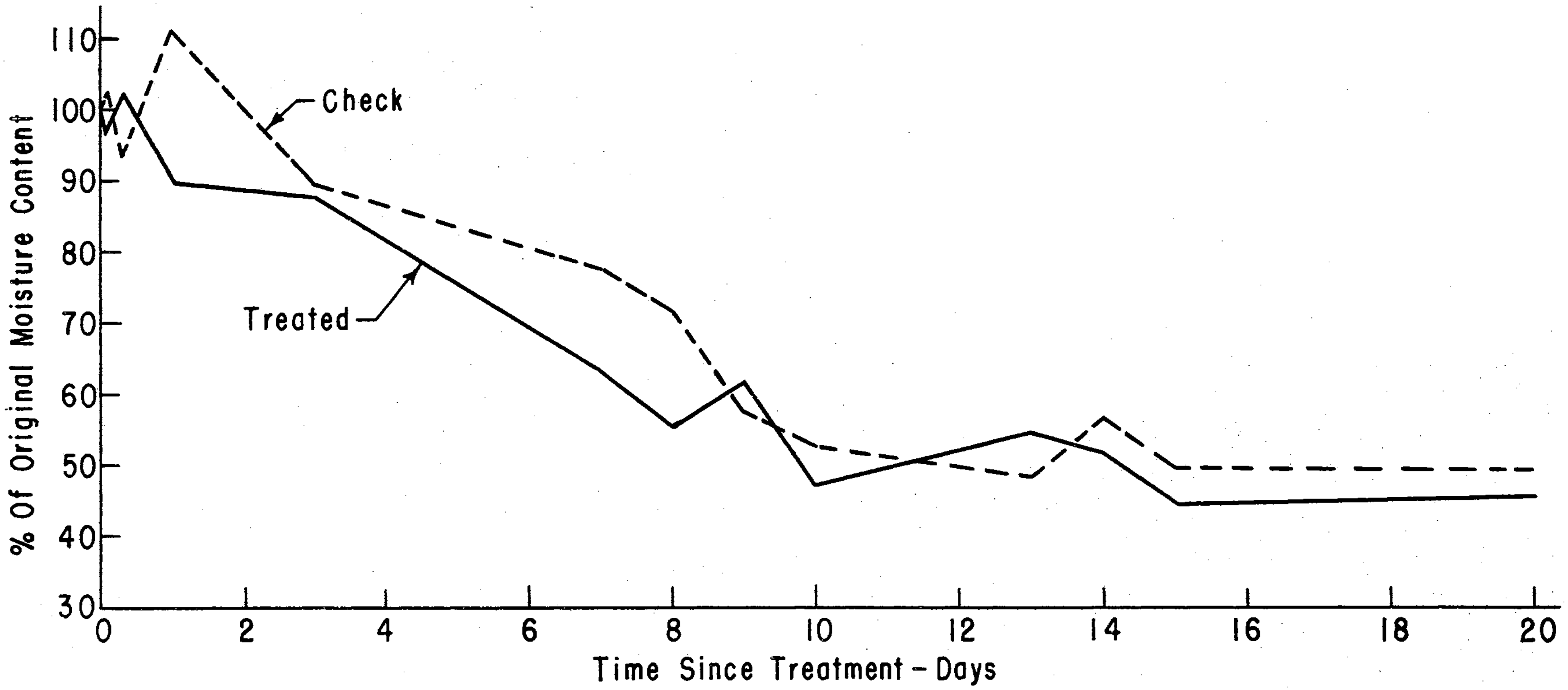

Figure 21. Per Cent of Original Moisture Content of Grain Sorghum Versus Time Since Treatment for 600° F Air and 5.45 Seconds (1 MPH) Exposure Time.

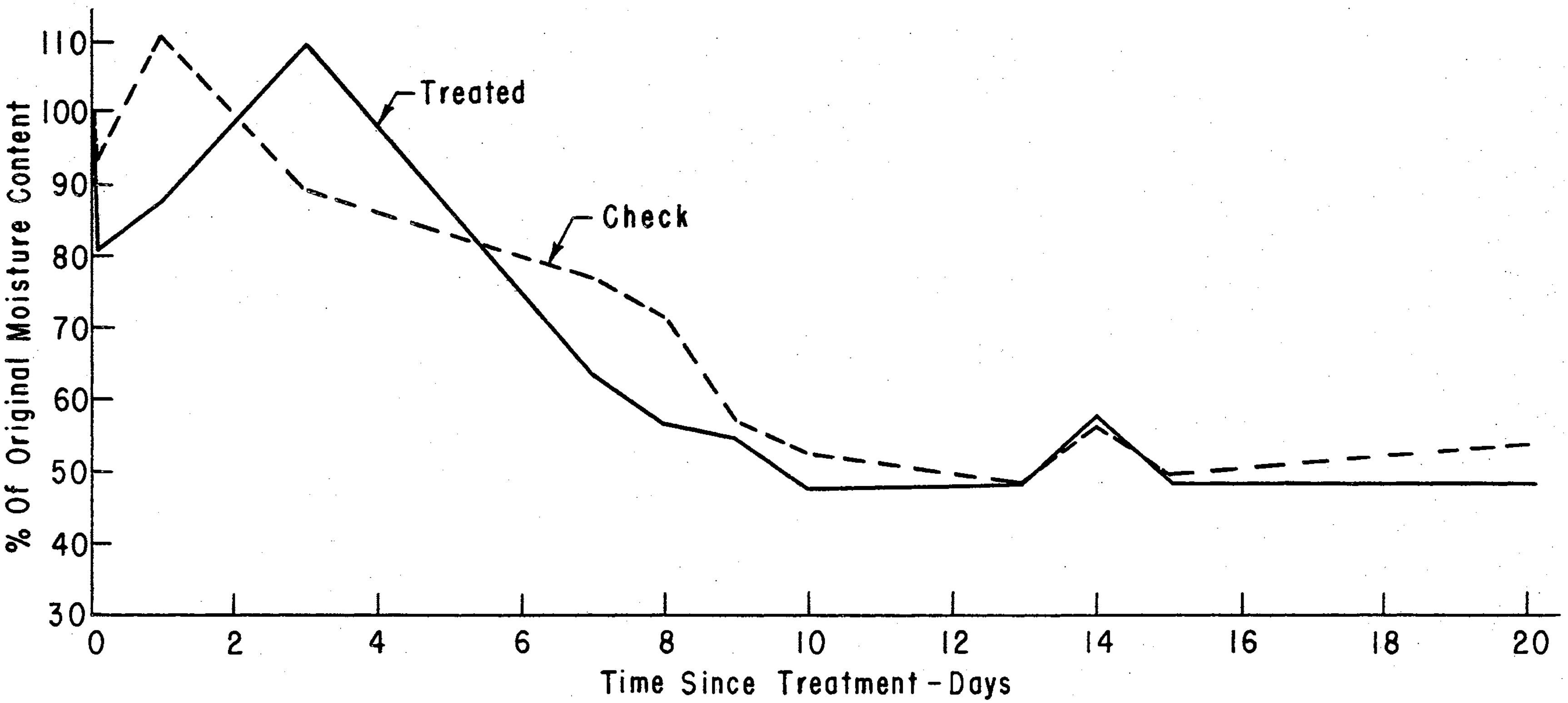

Figure 22. Per Cent of Original Moisture Content of Grain Sorghum Versus Time Since Treatment for 600° F Air and 2.73 Seconds (2 MPH) Exposure Time.

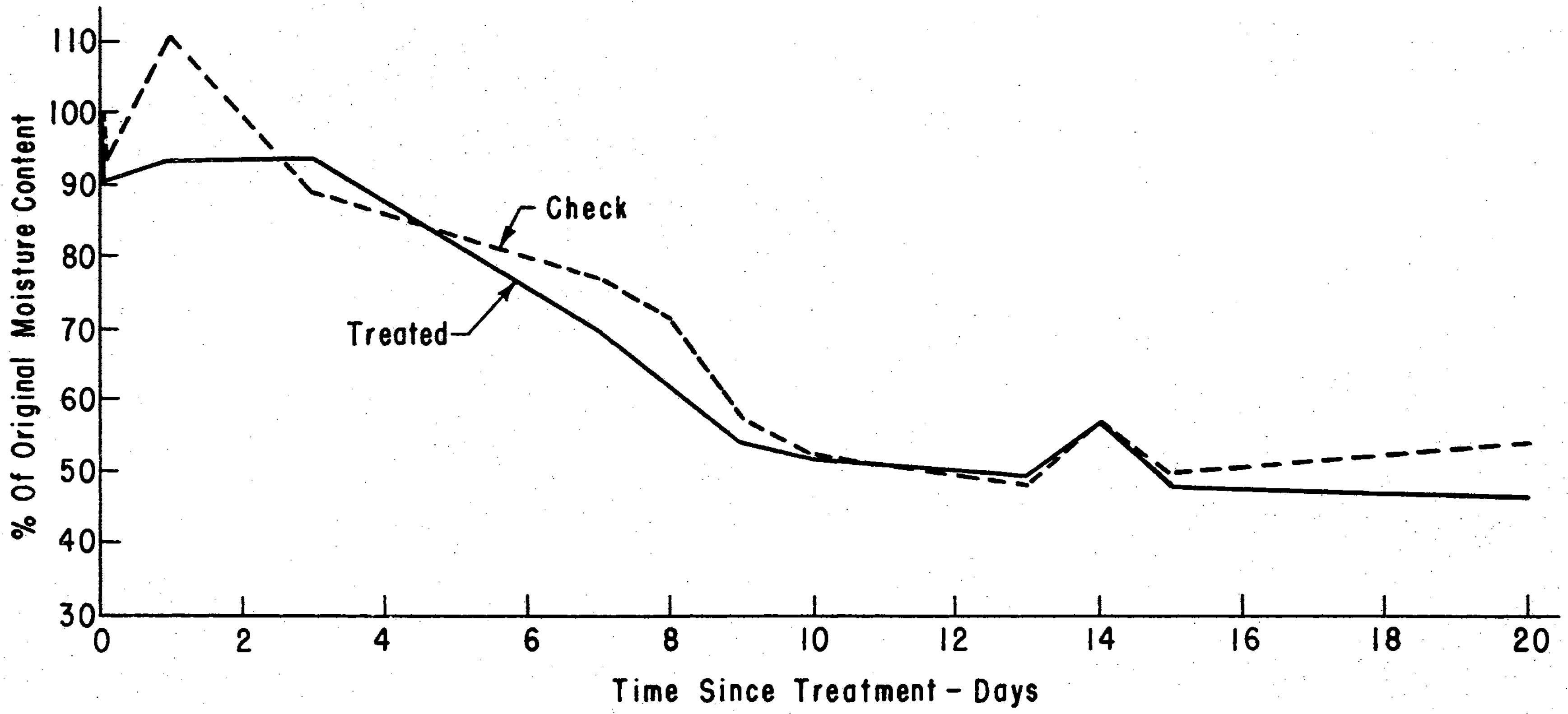

Figure 23. Per Cent of Original Moisture Content of Grain Sorghum Versus Time Since Treatment for 600° F Air and 1.82 Seconds (3 MPH) Exposure Time.

moisture content, and the grain sorghum in the treated plot contained 39 per cent of the original moisture content. Similar comparison can be made on Figures 17, 19, 20, 21, 22 and 23.

Peanut Studies

The experiment involving peanuts was also considered as a randomized block design. Appendix E presents the field data collected.

Table XII presents the drying rate of the peanuts during the period from digging until four days after digging. All treatments were applied at the same time; however, one set of treatments (referred to as second digging) were allowed to dry in the ground for one week. The other set of treatments (referred to as first digging) were dug following treatments. Values given in Table XII are moisture content calculated on the wet basis.

The observation was made that the moisture content in the treated plants actually increased between the two digging dates. In the same one-week interval the moisture content in the check plots, dug and not dug, decreased. The drying rate of the dug check plot was higher than the drying rate of the treated plants during the first digging. During the second digging, the treated plants did dry faster, but the difference in drying rates was not significant.

The observation was also made that the treated plants of the second digging were difficult to dig with conventional machinery. The leaves were dead; therefore, they shattered when the digger struck the plant. The plants were either unmoved by the digger or they were picked up and placed back in their same positions. The peanuts themselves were not exposed to much sunlight or air circulation after digging.

TABLE XII

PEANUT FIELD DRYING RATE AS A FUNCTION OF TIME FOR FIRST AND SECOND DIGGING

	First Digging		Second Digging	
Time From Digging	0 Days	4 Days	0 Days	4 Days
Severe Heat Treatment	38.4	26.2	41.7	21.3
Less Severe Heat Treatment	40.7	27.6	43.2	21.7
Check Treatment (Dug)	41.0	27.2	39.1	21.7
Check Treatment (Not Dug)	44.2	41.5	42.5	40.0
Moisture content drop during four days--per cent wet basis				
Severe Heat Treatment	12.2		20.4	
Less Severe Heat Treatment	13.1		21.5	
Check Treatment (Dug)	14.7		17.4	
Check Treatment (Not Dug)	2.70		2.5	

CHAPTER VII

DISCUSSION OF RESULTS

Cotton

Air temperature and exposure time were found to be significant in defoliation of cotton. These same factors along with fan speed and their interactions appeared as significant in the desiccation of cotton. These factors appeared as significant at the 0.05 alpha level. Treatments determined as significantly different seemed to be determined different more on the basis of forward speed (exposure time) than on air temperature or a combination of air temperature and forward speed. Attempts were made to combine air temperature and forward speed into a single unit that might have been used to describe treatments more completely; however, the equations obtained did not describe the results as well as did the equation used in the previous chapter.

Figures 15 and 16, respectively, present response surfaces of per cent defoliation and desiccation as a function of air temperature and exposure time. Above 70 per cent defoliation was accomplished by use of 600 degree Fahrenheit air between 2.83 and 5.30 seconds exposure time. Similar results were obtained by use of 500 degree Fahrenheit air above 4.3 seconds exposure time, and by use of 400 degree Fahrenheit air above 5.9 seconds exposure time. Air temperatures below 400 degrees Fahrenheit did not produce defoliation percentage above 70 per cent. One hundred per cent leaf kill was obtained at all exposure times above

2.15 seconds using 600 degree Fahrenheit air, and above 3.3 seconds using 500 degree Fahrenheit air. One hundred per cent leaf kill was attained with air temperatures above 460 degrees Fahrenheit. If Figure 16 were superimposed upon Figure 15, an optimum combination of per cent defoliated and per cent kill might be found. A maximum of 100 per cent kill and defoliation could possibly be found by locating a treatment combination attaining 100 per cent defoliation in Figure 15. At this 100 per cent level of defoliation, the level of desiccation is also 100 per cent. In this envelope of desirable results, i.e., bounded by the 70 per cent level of defoliation, desiccation reaches a minimum of 91 per cent. Air temperatures below 430 degrees Fahrenheit and exposure times above 4.7 seconds (within the 70 per cent defoliation curve) attain desiccation percentages between 91 and 100 per cent. Satisfactory defoliation and desiccation percentage result with treatment combinations within the 70 per cent defoliation curve.

Although a unique optimum treatment was not established in this study, treatments varied significantly. Eight significant differences were found in defoliation treatment results. Four significant differences were found in desiccation treatment results. As previously stated, these differences were based more on forward speed than on air temperature and fan speed.

The thermal applicator was found to be economically feasible. Satisfactory defoliation was accomplished at $1.64 per acre fuel cost.

Grain Sorghum

The subjection of the entire grain sorghum plant to a high temperature environment appeared as having potential. All treatments increased the drying rate over plants which were not treated. The drying conditions during the experimental period were not conducive to rapid drying. Several periods of high humidity and precipitation were recorded and may be observed in Figures 17, 18, 19, 20, 21, 22 and 23. Significant differences were found among treatments. Although a unique optimum treatment was not found, three significant treatment differences are presented in Table XI. Severe treatments, i.e., high air temperatures and high exposure times, resulted in the popping of the grain sorghum. "Popped" grain sorghum may have some feeding advantages in that it may be easier to digest; however, problems might arise in harvesting.

Peanuts

The exposure of peanut plants to high temperature air did not increase the field drying rate a significant amount. Peanuts treated actually dried at a slower rate than did the untreated plants in the first digging. In the second digging, the less severe treatment dried at a faster rate than did the severe treatment. Both treatments dried at a faster rate than did the check plot; however, this drying rate was not significant. The method of treating the plants and digging one week later was chosen arbitrarily and should not necessarily be considered as the best method of field drying peanuts. Using this method, the treated plants were difficult to harvest with the available machinery. Using the described methods, attempts to increase the field drying rate with the designed machine were unsuccessful.

CHAPTER VIII

SUMMARY AND CONCLUSIONS

Summary

An investigation was conducted to determine the feasibility of constructing a heat application unit which, with some modification, might serve as a prototype for commercial production of thermal applicators for biological material. The versatility of the unit was also investigated. The designed unit was evaluated by plant response to treatment combinations of air temperature, exposure time and fan speed. The unit was operated in mature cotton, and the per cent defoliation and desiccation was calculated. Defoliation as high as 87.35 per cent and leaf kill as high as 100 per cent was achieved. Exposure time and air temperature were found to be significant in defoliation of cotton plant leaves. Fan speed was found to be insignificant. Optimum treatment combinations for maximum defoliation and desiccation were determined and a polynomial expression was used in which per cent defoliation and per cent leaf kill may be predicted for all temperature and time combinations within the limits of this study. Temperatures below 400 degrees Fahrenheit did not produce satisfactory defoliation results. Within the 70 per cent defoliation envelope, a minimum of 91 per cent desiccation was achieved.

Grain sorghum was subjected to treatments similar to those used in cotton. In all cases, treated grain sorghum dried faster than did the untreated grain in the field. Severe treatments caused popping of the heads.

Peanuts were also subjected to treatments of air temperature and time combinations. Field drying rates of treated plants were either less than or insignificantly larger than the untreated plants. Plants which were not dug until one week after treatment were difficult to harvest with conventional machinery.

Thermal applicator modification suggestions are:

1. Installation of a self-ignition system which would not include the use of magnetos, individual wires and spark plugs for each burner.
2. Conversion of the tractor engine to an LP gas fuel system. This would eliminate a fuel tank on the unit.
3. Enlargement of the tractor hydraulic system to accommodate the fan drive. Excess weight might be eliminated and controls might be simplified.
4. Elimination of the present heat exchanger system. If the liquid gas could be circulated through the high temperature hydraulic return line or in front of the burners for a short period of time, the machine might be simplified.
5. Installation of a fast-acting modulating fuel control system. The ability to maintain a specific temperature within the hover without operator control would be advantageous.

Conclusions

1. It was possible to maintain a high temperature on the ground level using a vertical air stream with varying resistances.
2. Exposure time and air temperature was the most significant factors affecting thermal defoliation.
3. Fan speed was insignificant in thermal defoliation of cotton.
4. Cotton plants were induced to defoliate by use of a high temperature air stream (400 to 600° F) for a period of time (2.5 to 6 seconds).
5. Significant field drying of grain sorghum was achieved by subjecting the plants to a high temperature environment.
6. Significant field drying of peanuts was not achieved by subjecting the plants to a high temperature environment.
7. With modifications in the fuel system, hydraulic system and burner self-ignition system, the machine is a commercially producible unit.

Suggestions for Future Study

1. Examine other possible uses of the unit. Possibilities such as insect control, weed control, and soybean defoliation might be investigated.

2. A automatic temperature control might be devised for the unit. A quick reacting device is needed to maintain a constant temperature within the hover.
3. The necessity of the front doors should be investigated on this unit. Since the air stream is directed downward and toward the rear, the front doors may not be needed.
4. The possibility of increasing the drying rate of dug peanuts should be investigated. The peanuts could be dug, then subjected to a high temperature environment. The drying rate might be increased.
5. Investigate the drying rate of the cotton seed after being thermally treated. Excessive drying of cotton seed before ginning might be reduced.

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13. Shepherd, J. L., "New Techniques in Mechanized Peanut Production," Proceedings - Third National Peanut Research Conference, 1964, 44-45.

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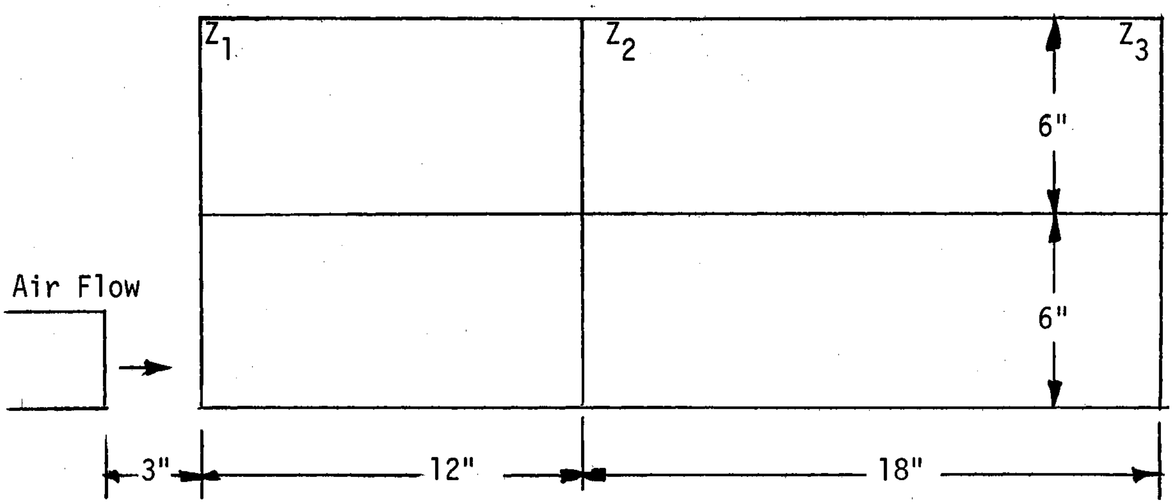
APPENDIX A

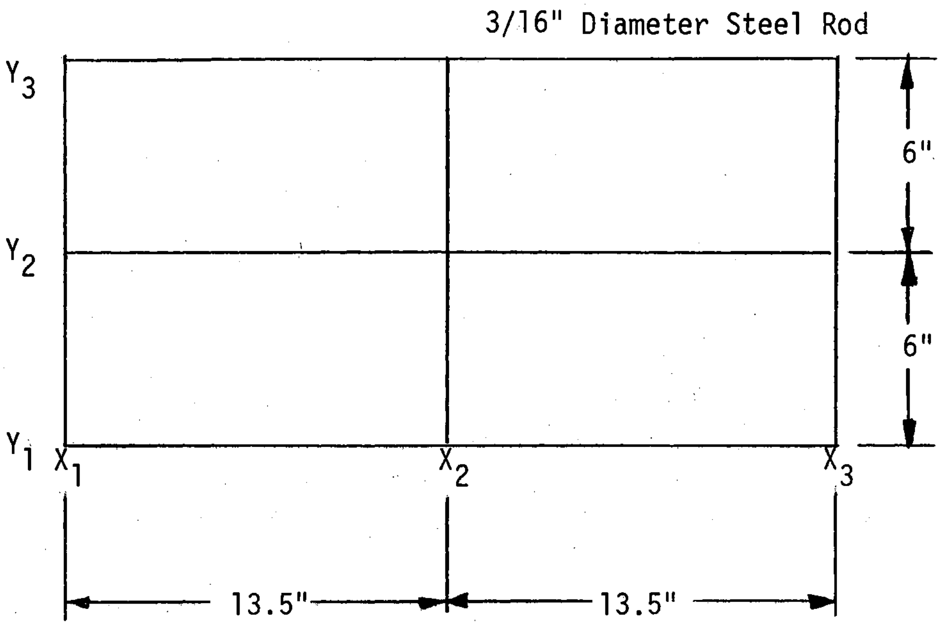
PRELIMINARY INVESTIGATION DATA

APPENDIX A-I



Burner located approximately 27 inches inside hover, in the center and perpendicular to the air flow. Temperatures were measured at the grid intersection points.

Side View



Front View

Preliminary Investigation Equipment

APPENDIX A-II

	Z_1			Z_2			Z_3		
	X_1	X_2	X_3	X_1	X_2	X_3	X_1	X_2	X_3
Y_3	-	-	-	-	-	-	-	-	-
Y_2	-	-	-	-	-	-	-	20	-
Y_1	230	210	270	120	160	130	50	150	80

Velocity in ft./min. at specified points recorded at a fan speed of 500 RPM and the burner off. A dash represents velocities too low to record with the velometer.

APPENDIX A-III

Z_1

Y_3			150		
Y_2			180		
Y_1			270		
	X_1		X_2		X_3

Temperature - °F

Z_2

			190		
Y_3			190		
			300		
Y_2	100	215	510	105	110
			490		
Y_1			170		
	X_1		X_2		X_3

Temperature - °F

Z_3

			240		
Y_3	105	150	260	145	110
			220		
Y_2	125	150	160	110	90
			125		
Y_1			130		
	X_1		X_2		X_3

Temperature - °F

Temperatures Recorded with a Thermocouple and Recording System at Given Points for Fan Speed = 500 RPM, Gas Pressure = 5 psi. A No. 1203 Gotcher Burner was used.

APPENDIX A-IV

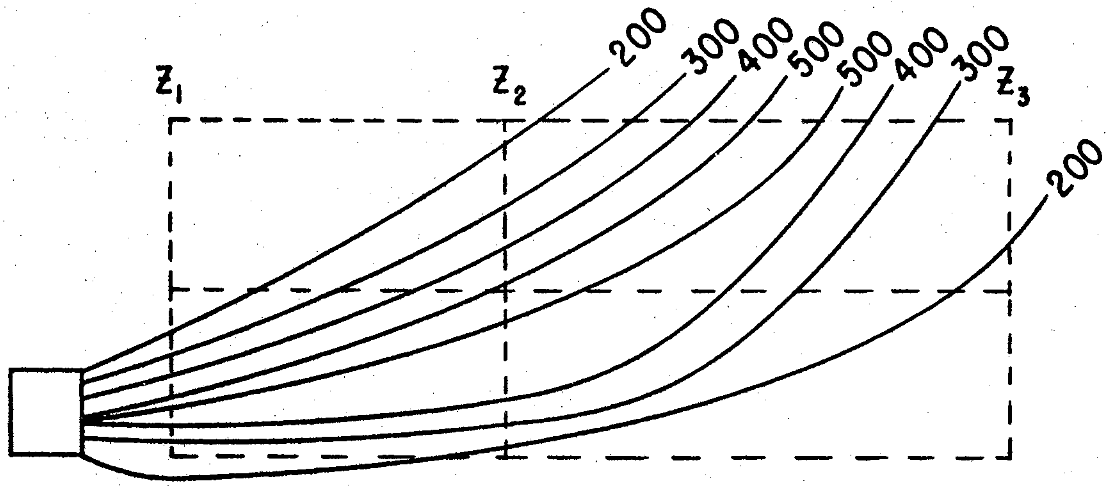
Z_3

			190		
Y_3			250		
			305		
Y_2	100	130	320	140	100
			270		
Y_1			180		
	X_1		X_2		X_3

Temperature - °F

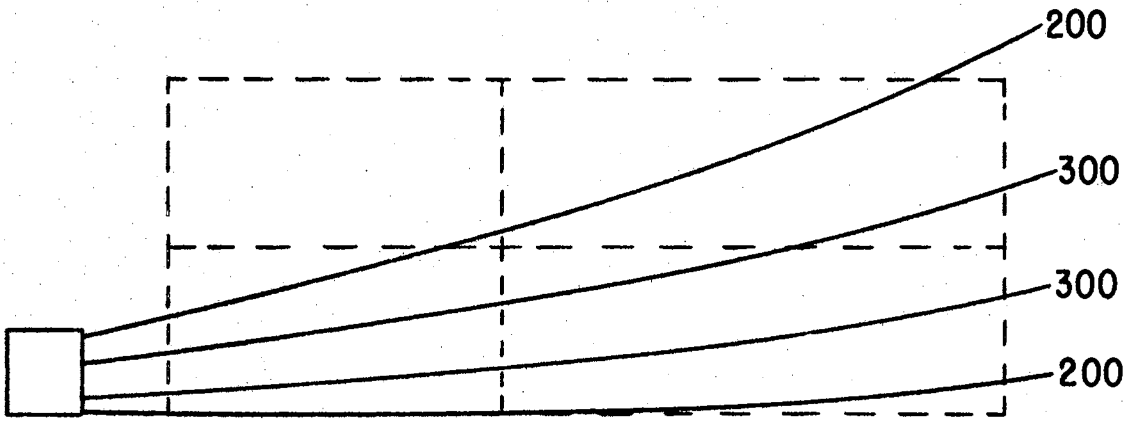
Temperatures Recorded with a Thermocouple and Recording System at Given Points for Fan Speed = 750 RPM, Gas Pressure = 5 psi. A No. 1203 Gotcher Burner was used.

APPENDIX A-V



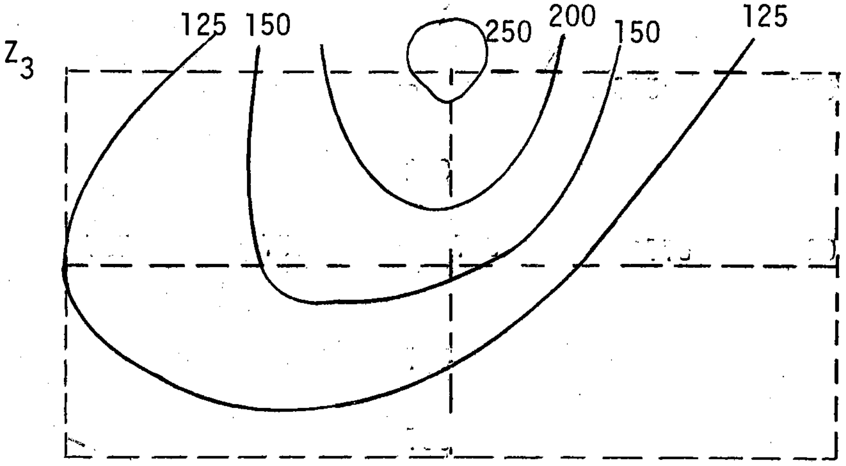
Profile of Center Section (X_2) - Temperature - °F
RPM = 500 Pressure = 5 psi

APPENDIX A-VI



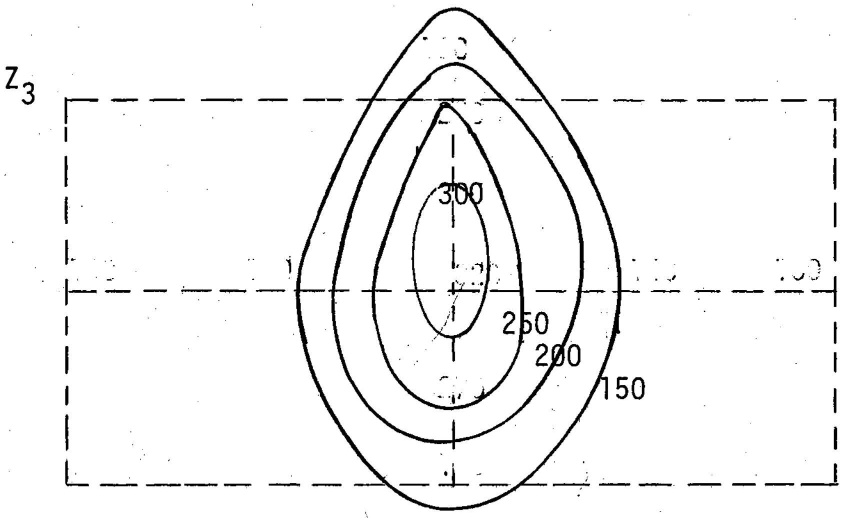
Profile of Center Section (X_2) - Temperature - °F
RPM = 750 Pressure = 5 psi

APPENDIX A-VII



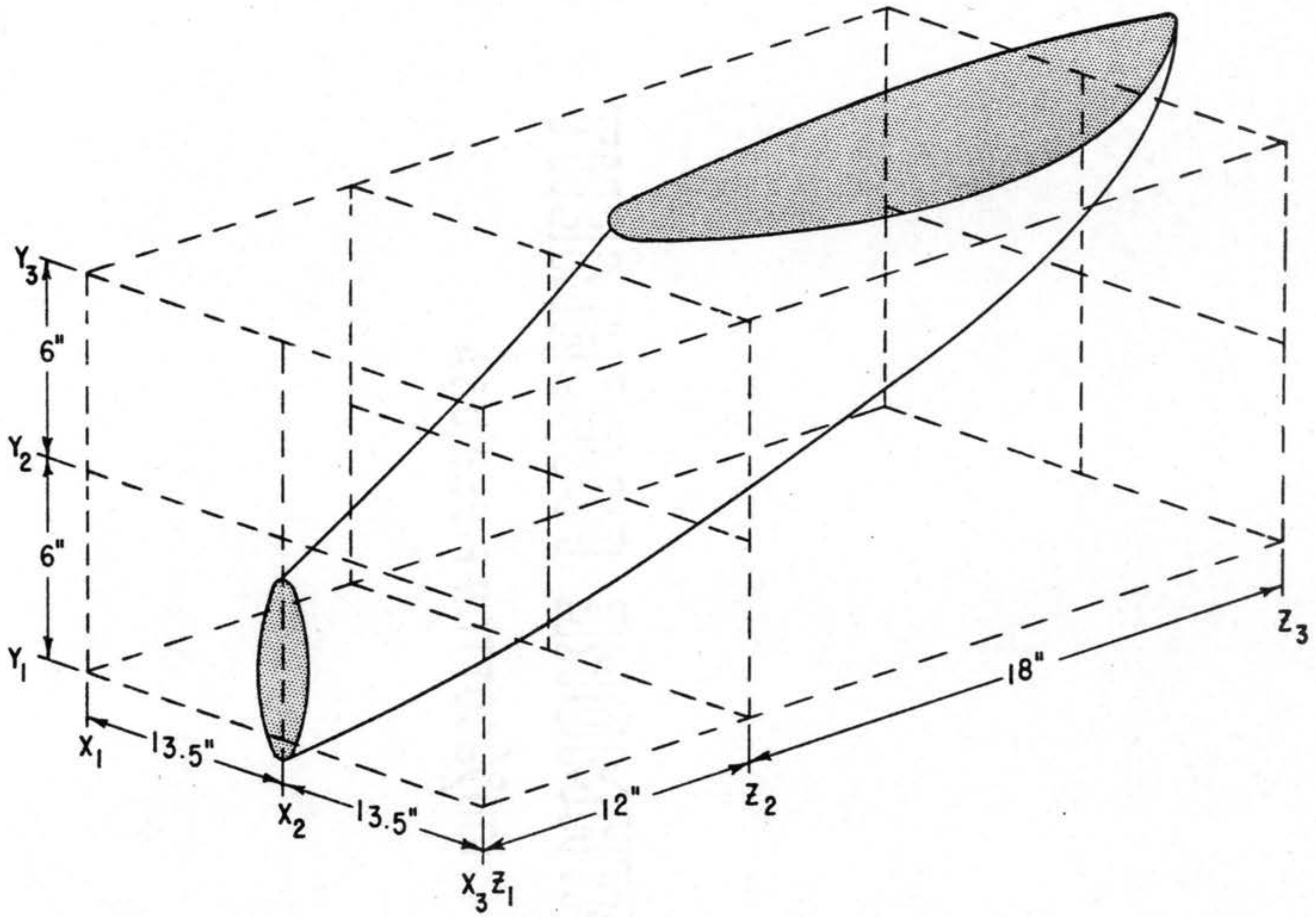
Air Temperature Cross Section at Position Z_3, 500 RPM, Gas Pressure = 5 psi.

APPENDIX A-VIII



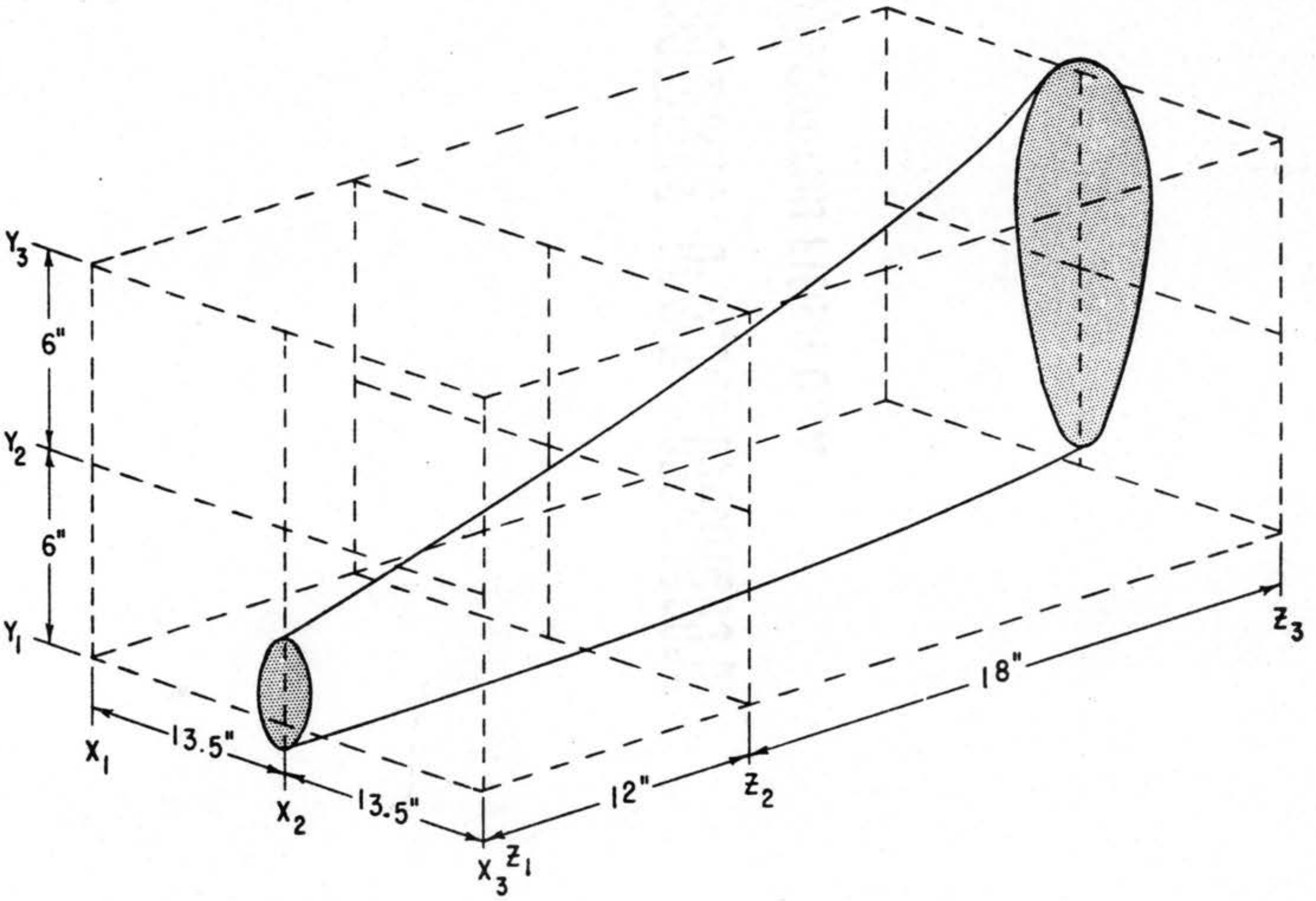
Air Temperature Cross Section at Position Z_3, 750 RPM, Gas Pressure = 5 psi.

APPENDIX A-IX



High Temperature Air Envelope, bounded by 200° F. Fan speed = 500 RPM, Gas pressure = 5 psi.

APPENDIX A-X

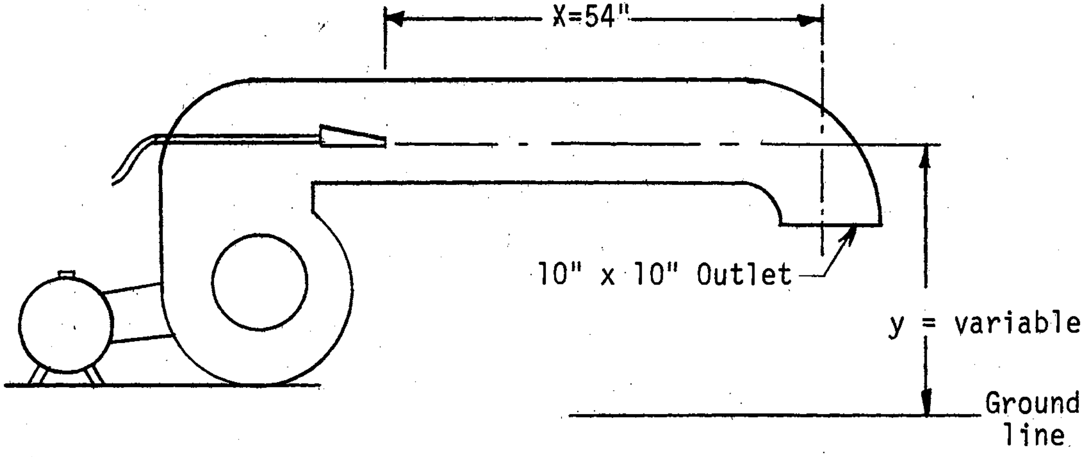


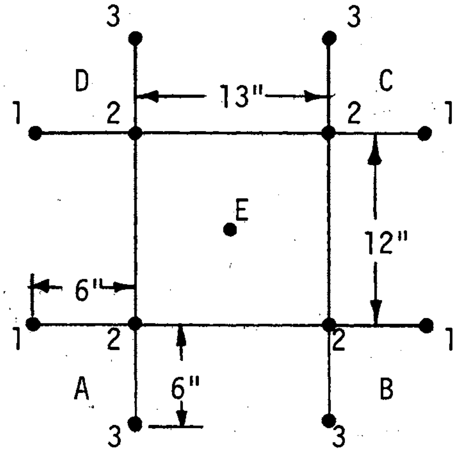
High temperature air envelope, bounded by 200° F. Fan speed = 750 RPM, Gas pressure = 5 psi.

APPENDIX B

PRELIMINARY INVESTIGATION DATA

APPENDIX B-I





Grid drawn on floor directly below the outlet.
● - Temperature points

Preliminary Investigation Equipment

APPENDIX B-II

HORIZONTAL VELOCITY IN FT./MIN. WITH THE BURNER OFF

RPM	Height Above Ground (Inches)	A			B			C			D			E
		1	2	3	1	2	3	1	2	3	1	2	3	
500	36	150	210	180	170	250	190	300	345	350	290	350	360	0
750	60	200	280	250	250	310	260	360	310	470	160	125	460	0

Velocity measurements were made with a small hand velometer.

APPENDIX B-III

Front

Left

Right

	210	
265	270	265
	365	
	290	
240	250	440
	185	

Back

Air temperature (°F) across the outlet. Fan speed = 500 RPM; burner pressure = 5 psi.

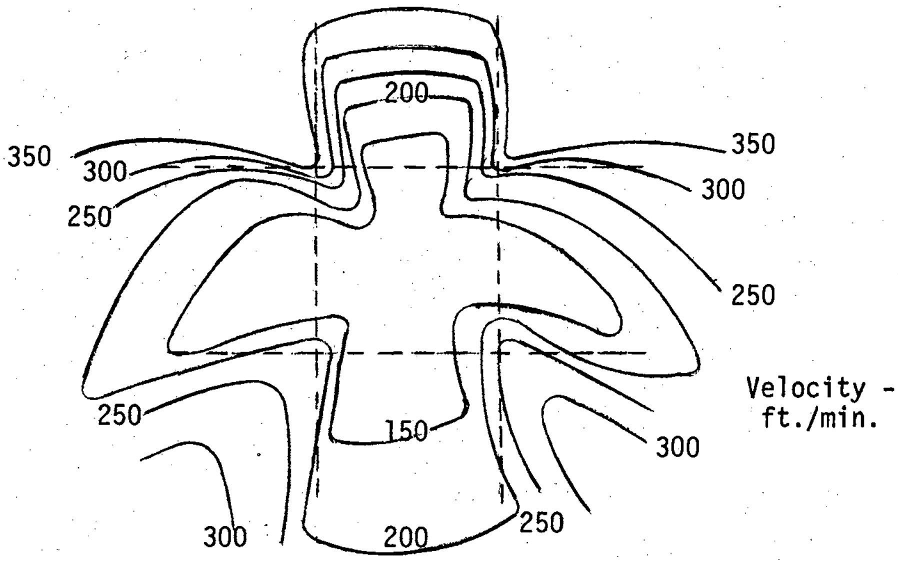
APPENDIX B-IV

TEMPERATURES MEASURED AT POSITIONS GIVEN IN APPENDIX B-I, °F

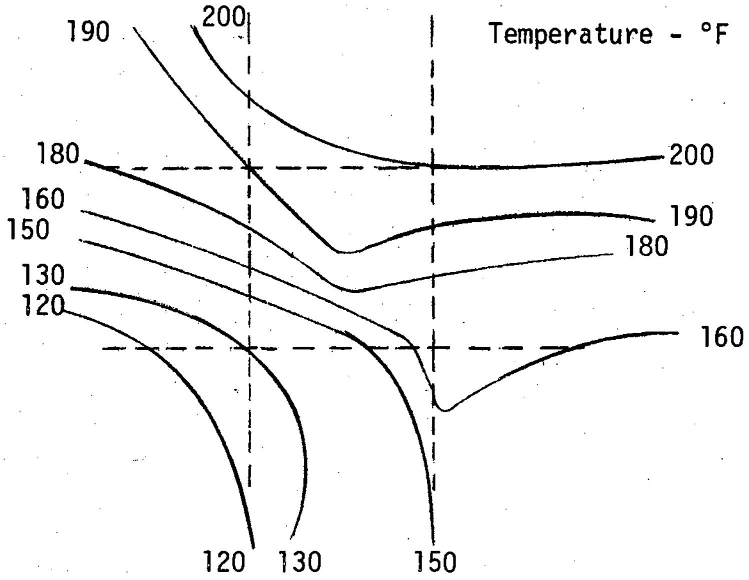
(Temperatures were recorded with a thermocouple and recording system.)

Fan Speed RPM	Height ( ) in.	Burner Pressure PSI	Type of Resistance	A			B			C			D			E
				1	2	3	1	2	3	1	2	3	1	2	3	
500	36	5	None	115	130	122	160	165	155	200	200	205	180	190	205	190
500	36	5	¾" Expanded metal 4" above floor	165	160	160	170	180	150	190	195	190	190	195	200	185
500	36	5	Sheet metal with 3/16" round holes spaced ¼"	120	120	115	110	105	100	140	145	145	155	165	180	175
500	48	5	None	140	140	135	140	145	140	180	185	185	175	167	180	175
500	60	5	None	125	120	115	120	122	115	145	155	160	155	145	160	150
500	60	5	¾" Expanded metal 4" above floor	110	115	115	112	110	107	155	155	160	160	155	155	145
750	60	5	None	130	130	125	132	135	135	145	150	150	145	147	150	150
750	60	10	None	150	150	145	170	175	165	190	200	200	170	180	190	195
750	60	10	¾" expanded metal 4" above floor	155	160	160	170	180	180	195	200	200	185	185	190	195

APPENDIX B-V

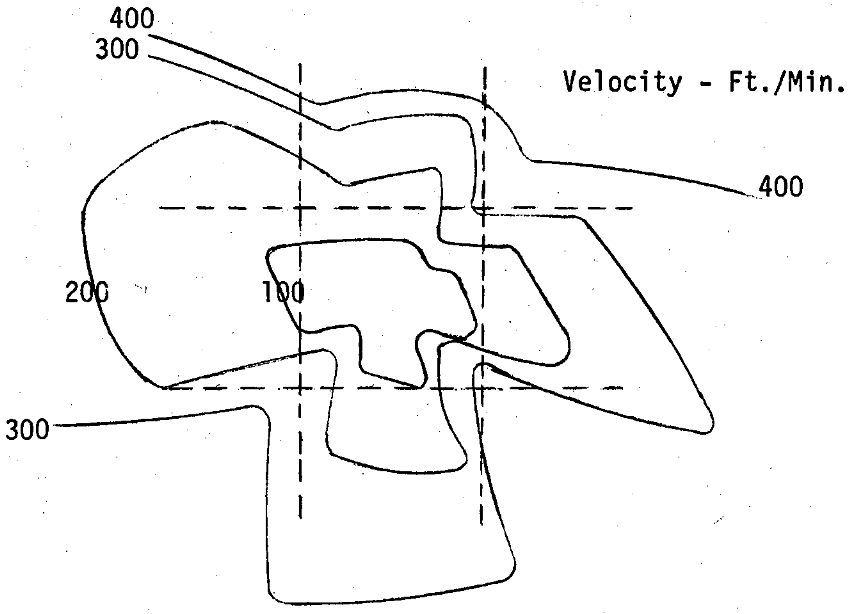


Horizontal Air Distribution Profile on the Ground Level with Fan Speed = 500 RPM, No Heat, and Outlet Height = 36" Above the Ground Level.

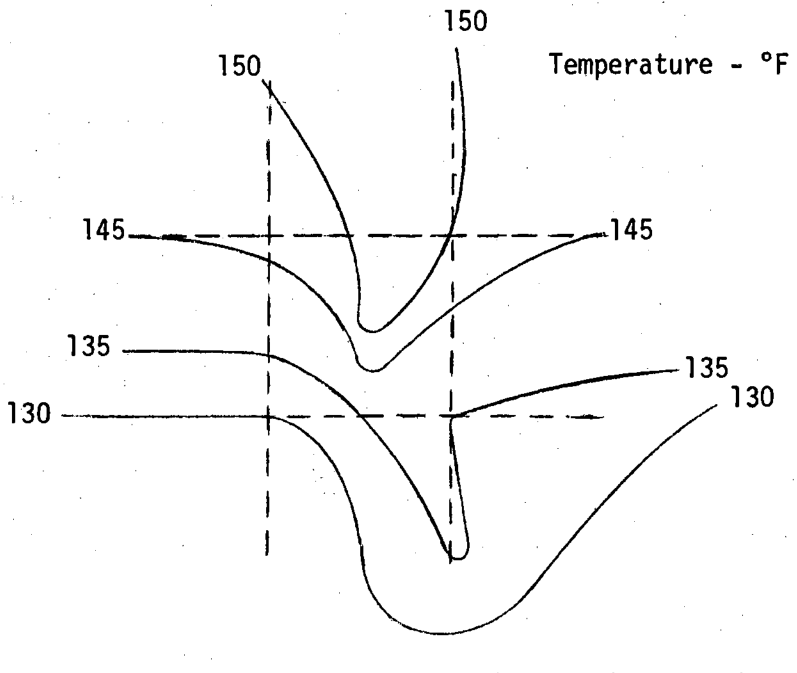


Air Temperature Distribution Profile on the Ground Level with Fan Speed = 500 RPM, Gas Pressure = 5 psi, and Outlet Height = 36" Above the Ground Level.

APPENDIX B-VI



Horizontal Air Distribution Profile on the Ground Level with Fan Speed = 750 RPM, No Heat, and Outlet Height = 60" Above the Ground Level.



Air Temperature Distribution Profile on the Ground Level with Fan Speed = 750 RPM, Gas Pressure = 5 psi, and Outlet Height = 60" Above the Ground Level.

APPENDIX B-VII

TEMPERATURE CHANGE AS A FUNCTION OF RESISTANCE, FAN SPEED, HEIGHT AND BURNER PRESSURE TEMPERATURES MEASURED AT POINTS GIVEN IN APPENDIX B-I, °F

(Temperatures were measured with a thermocouple and recording system.)

Constants	Variable		A			B			C			D		E
		1	2	3	1	2	3	1	2	3	1	2	3	
500 RPM	¾" expanded metal - 4" above floor	165	160	160	170	180	150	190	195	190	190	195	200	185
Height = 36"	3/16" round hole metal - 4" above floor	120	120	115	110	105	100	140	145	145	155	165	180	175
Pressure = 5 PSI	Decrease in temp due to increased resistance	45	40	45	60	75	50	50	50	45	45	30	20	10
Average temp decrease = 43.46														
Resistance = None	500 RPM	125	120	115	120	122	115	145	155	160	155	145	160	150
Height = 60 inches	750 RPM	130	130	125	132	135	135	145	150	150	145	147	150	150
Pressure = 5 PSI	Increase in temp due to increased fan speed	5	10	10	12	13	20	0	-5	-10	-10	2	-10	0
Average temp rise = 2.85														
Resistance - ¾" expanded metal - 4" above floor	Height = 36 inches	165	160	160	170	180	150	190	195	190	190	195	200	185
500 RPM	Height = 60 inches	110	115	115	112	110	107	155	155	160	160	155	155	145
Pressure = 5 PSI	Decrease in temp due to 2 ft. height increase	55	45	45	58	70	43	35	40	30	30	40	45	40
Average temp decrease = 44.31														
Resistance - None	Height = 36"	115	130	122	160	165	155	200	200	205	180	190	205	190
500 RPM	Height = 48"	140	140	135	140	145	140	180	185	185	175	167	180	175
Pressure = 5 PSI	Decrease in temp due to 1 ft height increase	-25	-10	-12	20	20	15	20	15	20	5	23	25	15
Average temp decrease = 10.07														
Resistance- None	Height = 36"	115	130	122	160	165	155	200	200	205	180	190	205	190
500 RPM	Height = 60"	125	120	115	120	122	115	145	155	160	155	145	160	150
Pressure = 5 PSI	Decrease in temp due to 2 ft height increase	-10	-10	- 7	40	43	40	55	45	45	25	45	45	40
Average temp decrease = 30.46														

APPENDIX B-VII (Continued)

Constants	Variable	A			B			C			D			E
		1	2	3	1	2	3	1	2	3	1	2	3	
750 RPM	Pressure 5 PSI	130	130	125	132	135	135	145	150	150	145	147	150	150
Height = 60"	Pressure 10 PSI	150	150	195	170	175	165	190	200	200	170	180	190	195
Resistance = None	Increase in temp due to 5 PSI increase	20	20	70	38	40	30	45	50	50	25	33	40	45
Average temp increase = 38.92														
500 RPM	Resistance = None	125	120	115	120	122	115	145	155	160	155	145	160	150
Height = 60"	Resistance = ¾" expanded metal 4" above floor	110	115	115	112	110	107	155	155	160	160	155	155	145
Pressure = 5 PSI	Decrease in temp due to increased resistance	15	5	0	8	12	8	-10	0	0	- 5	-10	5	5
Average temp decrease = 2.54														
750 RPM	Resistance = None	150	150	195	170	175	165	190	200	200	170	180	190	195
Height = 60"	Resistance = ¾" expanded metal 4" above floor	155	160	160	170	180	180	195	200	200	185	185	190	195
Pressure = 10 PSI	Decrease in temp due to increased resistance	- 5	-10	35	0	- 5	-15	- 5	0	0	- 5	- 5	0	0
Average temp increase = 0.38														

APPENDIX C

ANALYSIS OF VARIANCE SUMMARY FOR DEFOLIATION OF COTTON

ANALYSIS OF VARIANCE SUMMARY FOR DESICCATION OF COTTON

APPENDIX C-I

COTTON FIELD DATA

Trt No.	Air Temp °F	Ground Speed MPH	Fan Speed RPM	Plant No.	Plant Defoliation %	Plant Desiccation %	Average Defoliation for Treatment %	Average Desiccation for Treatment %	no. damaged bolls/no. counted
1	300	1	700	1	0.00	82.85	29.84	68.80	0/77
				2	0.00	57.14			
				3	48.86	70.17			
				4	68.32	68.32			
				5	0.00	76.47			
				6	31.37	89.44			
				7	41.92	57.76			
				8	48.28	48.28			
2	300	2	700	1	33.19	33.19	32.07	33.57	
				2	0.00	0.00			
				3	0.00	0.00			
				4	49.46	49.46			
				5	37.40	37.40			
				6	87.98	100.00			
				7	18.62	18.62			
				8	29.93	29.93			
3	300	3	700	1	13.06	13.06	14.21	14.21	
				2	0.00	0.00			
				3	25.89	25.89			
				4	0.00	0.00			
				5	.48	.48			
				6	0.00	0.00			
				7	58.35	58.35			
				8	15.91	15.91			

APPENDIX C-I (Continued)

Trt No.	Air Temp °F	Ground Speed MPH	Fan Speed RPM	Plant No.	Plant Defoliation %	Plant Desiccation %	Average Defoliation for Treatment %	Average Desiccation for Treatment %	no. damaged bolls / no counted
4	300	4	700	1	23.79	23.79	19.18	19.18	
				2	24.56	24.56			
				3	6.31	6.31			
				4	20.72	20.72			
				5	0.00	0.00			
				6	0.00	0.00			
				7	52.52	52.52			
				8	25.53	25.53			
5	400	1	700	1	88.76	100.00	78.41	98.88	1/70
				2	57.61	91.07			
				3	70.17	100.00			
				4	100.00	100.00			
				5	80.23	100.00			
				6	60.69	100.00			
				7	86.19	100.00			
				8	83.66	100.00			
6	400	2	700	1	20.81	100.00	32.73	80.13	0/86
				2	11.10	80.24			
				3	0.00	74.07			
				4	91.48	100.00			
				5	.48	100.00			
				6	10.25	20.81			
				7	48.86	65.91			
				8	78.88	100.00			

APPENDIX C-I (Continued)

Trt No.	Air Temp °F	Ground Speed MPH	Fan Speed RPM	Plant No.	Plant Defoliation %	Plant Desiccation %	Average Defoliation for Treatment %	Average Desiccation for Treatment %	no. damaged bolls / no counted
7	400	3	700	1	18.27	18.27	26.35	32.77	
				2	35.59	35.59			
				3	13.75	33.65			
				4	36.93	36.93			
				5	0.00	0.00			
				6	44.61	44.61			
				7	18.27	49.70			
				8	43.42	43.42			
8	400	4	700	1	0.00	0.00	13.98	17.22	
				2	44.61	52.52			
				3	0.00	4.99			
				4	15.91	15.91			
				5	33.19	40.61			
				6	10.15	15.77			
				7	7.99	7.99			
				8	0.00	0.00			
9	500	1	700	1	70.36	100.00	85.01	100.00	2/85
				2	100.00	100.00			
				3	100.00	100.00			
				4	91.83	100.00			
				5	77.53	100.00			
				6	65.91	100.00			
				7	80.09	100.00			
				8	94.38	100.00			

APPENDIX C-I (Continued)

Trt No.	Air Temp °F	Ground Speed MPH	Fan Speed RPM	Plant No.	Plant Defoliation %	Plant Desiccation %	Average Defoliation for Treatment %	Average Desiccation for Treatment %	no. damaged bolls / no counted
10	500	2	700	1	0.00	22.22	54.92	89.70	0/63
				2	52.48	100.00			
				3	35.59	95.39			
				4	70.40	100.00			
				5	31.82	100.00			
				6	92.57	100.00			
				7	88.21	100.00			
				8	68.32	100.00			
11	500	3	700	1	0.00	26.66	15.31	77.14	
				2	37.13	81.14			
				3	10.75	100.00			
				4	10.15	88.76			
				5	0.00	83.33			
				6	0.00	75.00			
				7	24.56	62.28			
				8	39.91	100.00			
12	500	4	700	1	0.00	15.78	19.22	26.67	
				2	36.93	43.94			
				3	13.75	33.65			
				4	0.00	0.00			
				5	20.81	31.37			
				6	0.00	0.00			
				7	49.70	55.99			
				8	32.61	32.61			

APPENDIX C-I (Continued)

Trt No.	Air Temp °F	Ground Speed MPH	Fan Speed RPM	Plant No.	Plant Defoliation %	Plant Desiccation %	Average Defoliation for Treatment %	Average Desiccation for Treatment %	no. damaged bolls / no counted
13	300	1	400	1	53.15	59.84	40.08	47.06	0/77
				2	69.75	73.78			
				3	90.79	100.00			
				4	12.90	23.79			
				5	11.10	20.98			
				6	40.50	40.50			
				7	4.97	10.25			
				8	37.44	47.32			
14	300	2	400	1	42.34	63.96	32.43	37.32	
				2	47.20	47.20			
				3	49.70	49.70			
				4	30.83	35.77			
				5	13.59	13.59			
				6	21.38	21.38			
				7	18.27	30.84			
				8	36.08	36.08			
15	300	3	400	1	26.09	36.65	27.00	32.79	
				2	0.00	0.00			
				3	8.90	8.90			
				4	48.03	55.46			
				5	40.28	53.55			
				6	48.89	48.89			
				7	43.84	43.84			
				8	0.00	14.99			

APPENDIX C-I (Continued)

Trt No.	Air Temp °F	Ground Speed MPH	Fan Speed RPM	Plant No.	Plant Defoliation %	Plant Desiccation %	Average Defoliation for Treatment %	Average Desiccation for Treatment %	no. damaged bolls / no counted
16	300	4	400	1	20.87	20.87	14.12	27.04	
				2	0.00	29.99			
				3	13.75	27.02			
				4	7.11	27.02			
				5	14.77	19.03			
				6	8.90	8.90			
				7	10.92	25.76			
				8	36.65	57.76			
17	400	1	400	1	89.44	100.00	68.34	93.96	0/78
				2	55.46	100.00			
				3	85.20	97.53			
				4	61.69	89.91			
				5	32.61	77.53			
				6	100.00	100.00			
				7	68.76	100.00			
				8	53.55	86.73			
18	400	2	400	1	38.23	38.23	29.80	38.44	
				2	10.51	10.51			
				3	45.01	80.36			
				4	25.76	25.76			
				5	4.52	11.10			
				6	48.86	57.38			
				7	21.38	21.38			
				8	44.14	62.76			

APPENDIX C-I (Continued)

Trt No.	Air Temp °F	Ground Speed MPH	Fan Speed RPM	Plant No.	Plant Defoliation %	Plant Desiccation %	Average Defoliation for Treatment %	Average Desiccation for Treatment %	no. damaged bolls / no counted
19	400	3	400	1	48.89	48.89	21.96	26.70	
				2	15.77	15.77			
				3	48.03	62.88			
				4	0.00	23.07			
				5	0.00	0.00			
				6	36.93	36.93			
				7	0.00	0.00			
				8	26.09	26.09			
20	400	4	400	1	0.00	11.76	10.39	20.80	
				2	12.96	44.61			
				3	0.00	0.00			
				4	0.00	31.81			
				5	13.75	13.75			
				6	31.85	31.85			
				7	24.56	24.56			
				8	0.00	8.10			
21	500	1	400	1	83.66	100.00	87.34	99.42	0/85
				2	100.00	100.00			
				3	92.71	100.00			
				4	85.17	100.00			
				5	95.39	95.39			
				6	86.73	100.00			
				7	55.07	100.00			
				8	100.00	100.00			

APPENDIX C-I (Continued)

Trt No.	Air Temp °F	Ground Speed MPH	Fan Speed RPM	Plant No.	Plant Defoliation %	Plant Desiccation %	Average Defoliation for Treatment %	Average Desiccation for Treatment %	no. damaged bolls / no counted
22	500	2	400	1	61.64	87.21	45.11	81.83	
				2	85.98	100.00			
				3	0.00	79.99			
				4	20.38	86.73			
				5	66.82	80.09			
				6	90.11	100.00			
				7	15.53	47.20			
				8	20.38	73.46			
23	500	3	400	1	12.96	20.87	13.27	20.50	
				2	4.81	16.70			
				3	3.49	3.49			
				4	53.12	74.43			
				5	22.92	22.92			
				6	0.00	0.00			
				7	8.90	8.90			
				8	0.00	16.66			
24	500	4	400	1	30.84	30.84	13.03	20.67	
				2	0.00	0.00			
				3	0.00	14.28			
				4	0.00	0.00			
				5	36.69	44.61			
				6	36.69	36.69			
				7	0.00	15.38			
				8	0.00	23.52			

APPENDIX C-I (Continued)

Trt No.	Air Temp °F	Ground Speed MPH	Fan Speed RPM	Plant No.	Defoliation %	Desiccation %	Average Defoliation for Treatment %	Average Desiccation for Treatment %	no. damaged bolls / no counted
25	600	2	700	1	80.09	100.00	77.36	98.94	3/88
				2	100.00	100.00			
				3	58.85	93.41			
				4	69.03	98.17			
				5	85.18	100.00			
				6	74.43	100.00			
				7	75.31	100.00			
				8	76.01	100.00			
26	600	3	700	1	23.33	100.00	36.77	76.45	0/76
				2	40.34	87.21			
				3	52.52	52.52			
				4	0.00	39.99			
				5	41.30	100.00			
				6	92.08	100.00			
				7	44.61	60.43			
				8	0.00	71.42			
27	600	4	700	1	.48	20.38	6.54	29.51	
				2	0.00	59.09			
				3	16.22	16.22			
				4	5.70	5.70			
				5	0.00	21.05			
				6	0.00	18.18			
				7	0.00	9.52			
				8	29.93	85.98			

APPENDIX C-II

ANALYSIS OF VARIANCE SUMMARY FOR DEFOLIATION OF COTTON

Source	D.F.	Sum of Sq.	Mean Sq.	F	
Total	215	210766.0	980.307		
Rep	7	2934.449	419.207	0.9109	
Trt	26	124073.50	4772.059	10.3693	Significant
A.T.	2	7803.617	3901.809	8.4783	Significant
G.S.	3	73517.42	24505.81	53.2493	Significant
F.S.	1	112.881	112.881	0.2452	
A.T. x G.S.	6	19484.73	3247.454	7.0564	Significant
A.T. x F.S.	2	910.478	455.239	0.9892	
G.S. x F.S.	3	448.174	149.391	0.3246	
A.T. x G.S. x F.S.	6	851.3	141.88	0.3082	
Remainder	3	20944.9	6981.633	15.171	Significant
Error	182	83758.04	460.209		

A.T. = Air Temperature

G.S. = Ground Speed

F.S. = Fan Speed

Level of Rejection = 0.05

APPENDIX C-III

ANALYSIS OF VARIANCE SUMMARY FOR DESICCATION OF COTTON

Source	D.F.	Sum of Squares	Mean Square	F	
Total	215	282840.4	1315.537		
Rep	7	941.609	134.515	0.3278	
Trt	26	207236.6	7970.638	19.4295	Significant
AT	2	27920.04	13960.002	34.0295	Significant
GS	3	73517.42	24505.81	59.7364	Significant
FS	1	4163.852	4163.852	10.1499	Significant
AT x GS	6	15404.84	2567.473	6.2585	Significant
AT x FS	2	3372.715	1686.357	4.1107	Significant
GS x FS	3	2262.672	754.224	1.8385	
AT x GS x FS	6	53525.061	8920.843	21.745	Significant
Remainder	3	27070.0	9023.33	21.995	Significant
Error	182	74662.18	410.232		

AT = Air Temperature

GS = Ground Speed

FS = Fan Speed

Level of Rejection = 0.05

APPENDIX D

GRAIN SORGHUM FIELD DATA

ANALYSIS OF VARIANCE SUMMARY FOR GRAIN SORGHUM EXPERIMENTS

APPENDIX D-I

GRAIN SORGHUM MOISTURE CONTENT OVER TIME FOR EACH TREATMENT AND TWO REPLICATIONS

(Values given in the table are moisture content of wet basis)

Days from Trt.	400-1 1	400-1½ 2	500-1 3	500-2 4	600-1 5	600-2 6	600-3 7	Check 8
Before Trt.	18.47	29.91	26.77	25.16	25.88	16.10	32.04	28.59
	29.08	22.11	20.27	22.64	22.54	21.77	18.72	20.78
Immediately after trt.	21.06	28.67	27.17	32.97	27.68	23.40	25.92	25.49
	22.34	15.48	26.26	22.47	18.99	23.00	20.04	23.99
3 hr. after trt.	18.88	30.54	29.33	19.61	22.14	19.92	26.91	24.85
	18.31	20.89	23.65	24.51	27.45	17.27	19.17	23.32
	24.11	24.08	21.62	25.81	23.34	19.47	23.76	27.97
1	22.34	24.84	19.91	16.78	19.90	21.08	23.66	26.81
	19.83	24.68	20.81	26.32	22.08	28.49	26.45	23.14
3	25.86	19.30	22.69	26.36	20.22	22.21	21.22	21.17
	21.26	14.76	16.12	23.17	14.92	13.51	19.45	20.55
7	14.19	14.70	15.77	16.19	15.75	15.95	15.96	17.66
	13.05	13.92	16.20	13.23	13.70	13.70	18.22	20.04
8	15.29	13.90	13.07	15.05	13.10	12.35	13.17	15.27
	12.12	12.43	14.33	17.66	13.10	13.40	14.15	13.75
9	12.84	12.34	11.93	11.72	16.74	11.93	13.20	14.50
	11.34	13.24	12.99	11.29	12.04	10.73	14.61	14.06
10	14.14	11.52	11.23	14.48	11.04	11.19	11.77	11.99
	11.06	10.47	10.24	11.20	14.36	11.22	13.00	11.90
13	10.55	9.93	11.17	11.12	11.90	11.27	11.91	12.12
	12.84	12.71	12.93	13.10	12.36	13.30	14.74	13.90
14	12.55	12.67	12.80	13.01	12.80	13.44	13.76	13.99
	11.60	11.56	10.37	13.71	10.86	10.77	12.45	12.01
15	11.37	10.42	11.10	11.18	10.71	11.81	11.78	12.54
	10.63	10.99	10.79	10.80	10.61	11.41	12.01	12.96
20	10.67	10.87	10.69	10.75	11.32	11.28	11.55	11.29
	11.11	10.88	10.70	11.04	10.51	11.43	11.98	11.45
21	10.80	10.88	11.03	10.90	11.48	11.34	11.95	11.20

APPENDIX D-I (Continued)

Days from Trt.	400-1 1	400-1½ 2	500-1 3	500-2 4	600-1 5	600-2 6	600-3 7	Check 8
22	10.24	10.41	10.12	10.14	10.38	10.29	11.93	10.88
	10.27	9.88	9.92	10.24	10.50	10.84	11.15	10.55
23	10.04	9.85	9.78	10.12	10.38	10.47	10.74	10.90
	10.03	10.02	9.99	10.04	11.33	10.23	10.82	10.82

APPENDIX D-II

ANALYSIS OF VARIANCE SUMMARY FOR GRAIN SORGHUM EXPERIMENTS

Source	DF	Sum of Squares	M.S.	F	
Total	255	8610.9228			
Block	15.	7226.7774	481.785	119.991	Significant
Treatment	7.	105.0703	15.0100	3.738	Significant
Exp. Err.	105.	421.5927	4.015	0.5993	
Sam Err.	128.	857.4824	6.699		

Level of Rejection = 0.05

APPENDIX E

PEANUT FIELD DATA

APPENDIX E

PEANUT FIELD DATA

(Values given in the table are moisture Content % - wet basis)

Days after Digging	Treatment 1 400°F 3 MPH 1st Dig	2 400°F 3 MPH 2nd Dig	3 600°F 1 MPH 1st Dig	4 600°F 1 MPH 2nd Dig	5 Dug Check 1st Dig	6 Dug Check 2nd Dig	7 Not Dug Check 1st Dig	8 Not Dug Check 2nd Dig
0	37.44	42.07	42.93	47.79	41.75	41.64	39.96	42.75
	35.74	46.15	39.02	40.23	42.09	36.45	44.52	42.80
	41.18	41.88	37.14	41.29	43.75	38.18	48.24	41.96
	37.94	38.47	38.56	40.11	40.05	37.74		
	39.01	42.56	41.26	43.60	39.47	40.62		
	38.63	38.89	45.40	46.43	43.34	39.86		
2	33.54		35.00		33.76		42.72	
	36.11		35.81		36.51		42.78	
	36.42		34.47		36.02		45.48	
	31.47		34.04		34.66			
	35.83		37.13		34.10			
	35.58		38.14		37.19			
4	24.85	23.53	29.03	25.11	26.07	22.18	40.42	36.59
	27.96	23.51	26.89	24.36	26.46	22.82	40.62	43.69
	25.77	20.10	25.03	17.94	27.75	20.67	43.42	39.58
	25.74	20.91	26.89	19.13	28.95	20.94		
	25.91	20.80	29.18	21.66	26.52	22.58		
	26.96	18.90	28.53	22.22	27.61	20.83		

APPENDIX E (Continued)

Days after Digging	Treatment							
	1 400°F 3 MPH 1st Dig	2 400°F 3 MPH 2nd Dig	3 600°F 1 MPH 1st Dig	4 600°F 1 MPH 2nd Dig	5 Dug Check 1st Dig	6 Dug Check 2nd Dig	7 Not Dug Check 1st Dig	8 Not Dug Check 2nd Dig
8		12.04		12.17		11.32		36.57
		13.36		14.87		13.58		38.87
		10.48		11.29		10.14		38.86
		13.30		11.82		11.52		
		10.84		12.32		12.82		
		9.29		14.53		11.11		

VITA

BUDO DOYLE PERRY

Candidate for the Degree of

Master of Science

Thesis: THERMAL APPLICATOR FOR FIELD CROPS

Major Field: Agricultural Engineering

Biographical:

Personal Data: Born at Fort Gibson, Oklahoma, October 23, 1943, the son of W. G. and Sarah J. Perry.

Education: Graduated from Fort Gibson High School, Fort Gibson, Oklahoma in 1961. Received the Bachelor of Science degree in Agricultural Engineering in January, 1966, from Oklahoma State University; completed the requirements for the Master of Science degree in May, 1967.

Professional Experience: Graduate Research Assistant for one year and Graduate Teaching Assistant for one semester for the Agricultural Engineering Department, Oklahoma State University.

Name: Budo Doyle Perry Date of Degree: May 28, 1967

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: THERMAL APPLICATOR FOR FIELD CROPS

Pages in Study: 101 Candidate for Degree of Master of Science

Major Field: Agricultural Engineering

Scope and Method of Study: The feasibility of designing and constructing a commercially producible thermal applicator was investigated. The flow pattern of a high temperature air stream was investigated. The thermal applicator was evaluated by plant response to air temperature, exposure time and fan speed. Cotton, grain sorghum, and peanuts were the crops used. Attributes evaluated were per cent defoliation and per cent desiccation in cotton and per cent moisture content decrease in grain sorghum and peanuts. The field tests were conducted using mature plants under actual harvest conditions.

Findings and Conclusions: It was possible to maintain a high temperature on the ground level using a vertical air stream with varying resistances. Exposure time and air temperature were significant factors affecting thermal defoliation. Fan speed was insignificant in thermal defoliation of cotton. The maximum per cent defoliation and desiccation found was 87 and 100 per cent, respectively. Temperatures below 400° F did not produce satisfactory defoliation results. All temperature-time combinations within the limits of this study resulted in increased field drying rates in grain sorghum. Subjection of peanuts plants to high temperature air did not significantly increase the field drying rate. Peanut plants which had been treated one week prior to harvest were difficult to harvest with conventional machines.

It was concluded that the following modifications were needed: Installation of a self-ignition system which would not include the use of magnetos, individual wires and spark plugs for each burner; conversion of the tractor engine to an LP gas fuel system; enlargement of the tractor hydraulic system to accommodate the fan drive; elimination of the present heat exchanger by liquid fuel circulation through the hydraulic return supply or in front of the burners; installation of a fast acting, modulating fuel control system. Modified in this manner, the unit could serve as a prototype for commercial production.

ADVISER'S APPROVAL______________________________________