5-1-1960

The Portable Floor Plate Brooder

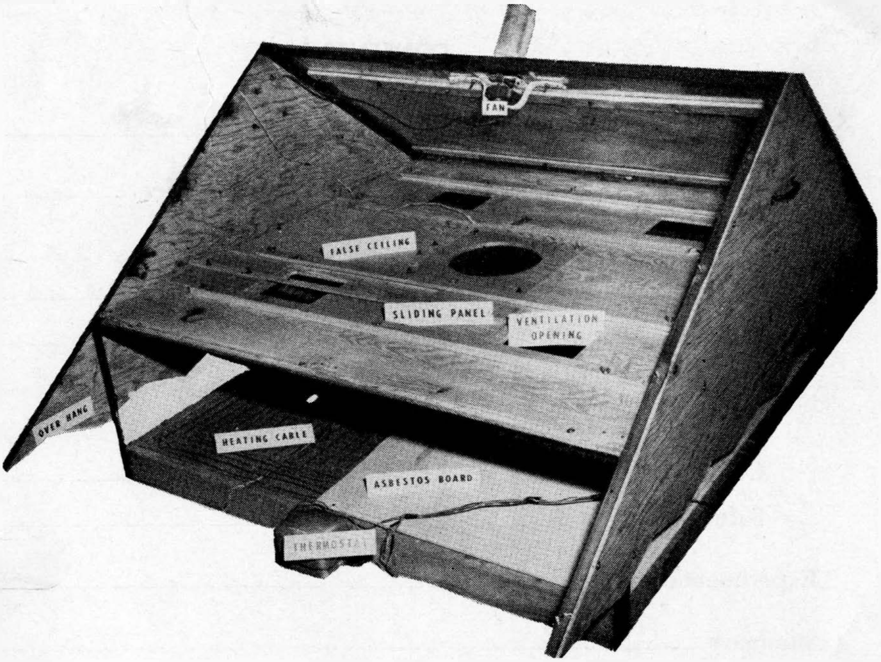
M. D. Paine

H. H. DeLong

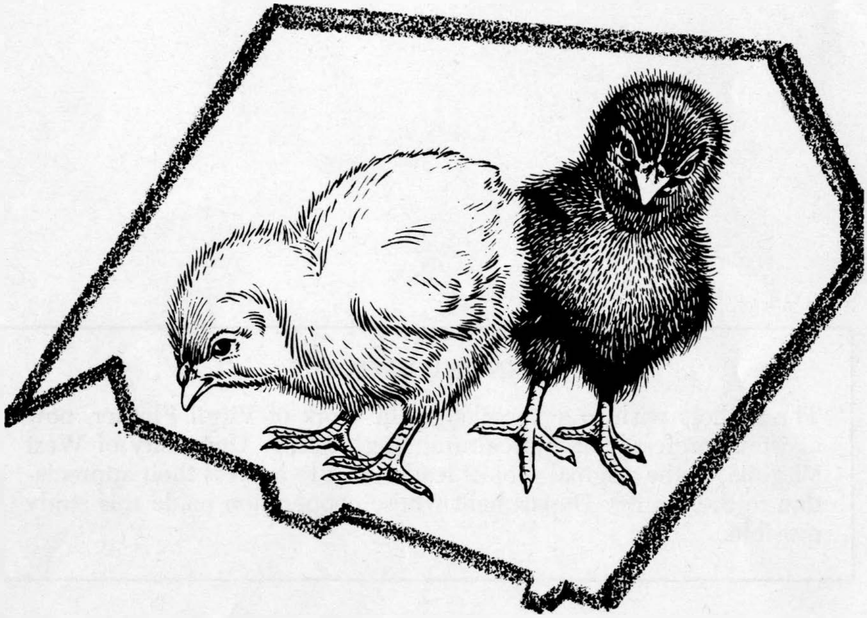
C. W. Carlson

10,

Bulletin 490



the portable floor plate brooder



Agricultural Engineering Department
AGRICULTURAL EXPERIMENT STATION
South Dakota State College, Brookings

CONTENTS

5M—5-60—7907

ACKNOWLEDGEMENTS

The authors wish to acknowledge the work of Virgil Flesher, now assistant professor of Agricultural Engineering, University of West Virginia, as the original project leader, and to express their appreciation to the Poultry Department whose cooperation made this study possible.

the portable floor plate brooder

MYRON D. PAINE, H. H. DELONG, C. W. CARLSON[1]

To avoid being caught in the squeeze between lower prices and higher cost, poultrymen have been forced to seek more efficient methods of raising poultry. This is especially true in South Dakota where poultry is usually one phase of a diversified farm operation. The average farmer has not been able to depend upon a large volume to reduce the cost per unit. The cold climate is a further handicap to the farmer of South Dakota. He cannot overlook the most economical methods of brooding. For this reason there has been considerable interest in the floor plate brooder and its adaptability to this area.

HISTORY OF ELECTRIC BROODING

The hover brooder has been used for many years by poultry raisers. The original hovers were semiclosed chambers surrounding gas or oil burners. These brooders were economical because the heating unit kept the chickens warm without heating the entire building. The first electric brooders originated when resistance units were used to replace the burners. These units, called conventional brooders throughout the rest of the bulletin, are still popular with poultry raisers. Many different models of the same basic design—hover over electric resistance heating unit—are available.

The radiant heat lamp has made a rapid gain in popularity in recent years. Because heat is developed only when the radiant energy strikes an object, the hover may be eliminated except in extreme cold, making the units easy to install. However, despite their initial low cost, tests have shown that the operating expense of heat lamps is greater than other brooding methods.[2] However, a conventional electric brooder with

[1]Instructor in Agricultural Engineering, Professor of Agricultural Engineering, Professor of Poultry Husbandry, respectively, South Dakota State College Agricultural Experiment Station.

[2]J. H. Hough, "Report on a Portable Underheat Brooder Using Electric Soil Heating Cable," Department of Agricultural Engineering, Louisiana Agricultural Experiment Station, Baton Rouge, La.

poor management may be almost as expensive. Many poultrymen supplement the lamps with a polyethylene hover. There are no simple controls to regulate temperature and the lamps are either on or off. In the hands of a careless person the heat lamps are still a potential fire hazard.

In an effort to reduce operating costs farmers and researchers in the southern United States began to use the floor plate brooder. The heating element of the floor plate is thermoplastic insulated soil heating cable with a rating of 5 watts per foot. The heating cable is sandwiched between insulating material on the bottom and asbestos board on the top. The entire unit is laid on the floor of a brooder house and a hover placed over it. The young chickens brood on the surface of the asbestos board.

These units were considered very successful in the South. However, there was serious doubt that the brooders were adaptable to the cold climate of South Dakota, especially for poultrymen who favor cold room brooding or who cannot afford to heat the entire brooder house.

Research conducted at the poultry farm at South Dakota State College has shown that, except for extremely cold weather, the portable floor plate brooder is practical and economical in this region. With proper precaution and/or with well insulated brooder houses the plate brooder can also be operated economically in the coldest of weather, as has been demonstrated by electric co-operative installations.[3]

ADVANTAGES AND DISADVANTAGES OF THE FLOOR PLATE BROODER

The first obvious advantage of a floor plate brooder is that it is much more economical than other methods of brooding. Expected savings are about 65% of the operating cost of heat lamps. There are two reasons for this economy; first, the heat is produced over a large area near the chickens; second, a hover is used to prevent rapid loss of heat.

The heated floor is always dry and is very easy to clean, although normally little cleaning is required during the brooding period.

The floor plate brooder is portable. Small units can be handled by one man. Two men can easily handle the larger 4 by 8 foot units. Individual units can be combined to make a brooder for any size flock, thus allowing the poultry man a large amount of flexibility.

The materials for the brooder are easily obtainable. With the exception of heating cable, wiring, and thermostat, (available in mail order catalogs) most of the materials are usually available on the average farm. Likewise, the brooder can easily be built with normal farm tools. In some areas local carpenters will construct and sell the entire units at reasonable cost. If built right, the brooder can be easily dismantled and placed into flat storage by one man in less than 10 minutes. Reas-

[3]Private communication with personnel of Sioux Valley Electric Association, Colman, South Dakota, and results of chick brooding test (1958), Codington-Clark Electric Co-operative, Inc., Watertown, South Dakota.

sembling of the hover may be done almost as rapidly.

The main disadvantages of the floor plate brooder are the original construction time and cost, a problem of ventilation, and failure in extreme cold weather unless the hover is well insulated.

CONSTRUCTION OF A FLOOR PLATE BROODER

The plans and list of materials at the back of this bulletin are presented as a guide for those who wish to build their own brooders. Comparisons of the plans with photos contained elsewhere in the bulletin should clarify most details.

To satisfy particular conditions or personal preference, hovers and floor plate heating units may be altered as to size, shape, and materials. However, there are six basic requirements that should be considered in the design of a good floor plate brooder.

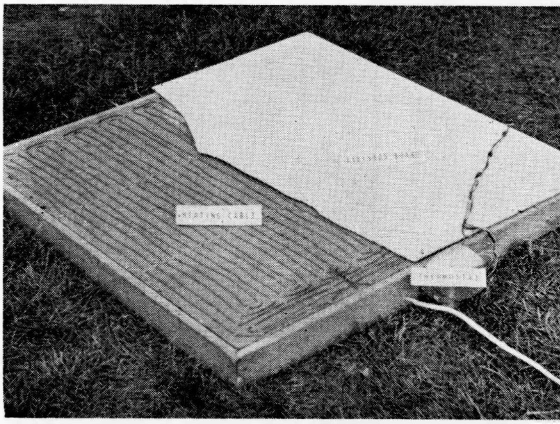
1. Accurate thermostatic control should be provided.
2. Adequate heat should be maintained.
3. Adequate ventilation should be provided.
4. A temperature transitional zone should be provided.
5. The unit should be convenient for the operator.
6. Safe wiring practice should be observed.

Accurate Thermostat Control

A capillary tube thermostat is recommended. Although rather expensive (approximately $12) the thermostat pays for itself by conserving power. Capillary thermostats are usually of the indicating type which allows them to be set for a given temperature. They can also be used as a thermometer by listening for the "click" as the dial is turned. The plate brooder is so economical that a person should allow himself the convenience of not having to calibrate and check a wafer (air) thermostat each time brooding begins.

The best and most ideal control of temperature can be achieved when the capillary bulb is placed on the surface of the floor plate, preferably across the corner as shown in figure 1 or otherwise near the edge. With this arrangement the chickens may lie right on the thermostat. At night, the chickens begin to nestle down around the edge of the floor plate. Body heat plus the insulating effect of their bodies re-

Figure 1. Floor plate heating unit showing asbestos board, thermostat, and soil heating cable. Note location of the thermostat capillary tube.



acts to shut off the thermostat. The plate actually cools down, but, if the thermostat is adjusted correctly, the chickens are kept warm and comfortable. If they become chilly the chickens may move to the warmer center of the brooder. The thermostat will then cool off and will turn on the heating cable.

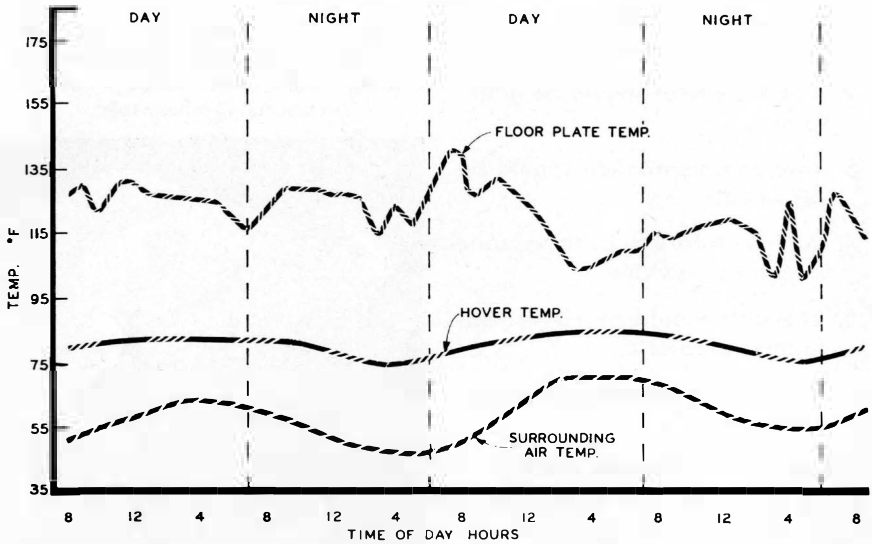
Figure 2 shows a typical daily cycle of temperatures. Notice how the warm floor plate kept the hover warm during the day and how it cooled it down as the chickens began to rest upon it. The chickens were still comfortable when the hover temperature dropped because they got their heat from the floor plate.

The capillary thermostat installed as described above should be set at approximately 100 to 110°F. at the start of brooding and reduced 5°F. a week for 4 weeks. After that it can be left at 80°F. until the end of brooding. The thermostat must be set slightly higher than the required air temperature (95°F. at start) because of the heat it receives from the plate.

The next best arrangement is a wafer thermostat beneath the asbestos board. The best position for the thermostat is in a compartment located so that the thermostat can react to both hover air temperature and to the temperature directly under the surface of the heating unit. This location is usually in a corner. Access to the thermostat must be made either through a hinged lid or by controls protruding through holes in the floor plate.

Thermostats depending upon the air temperature or the surface temperature of the floor plate in a re-

Figure 2. Typical daily curve of temperatures obtained with capillary tube thermostat.



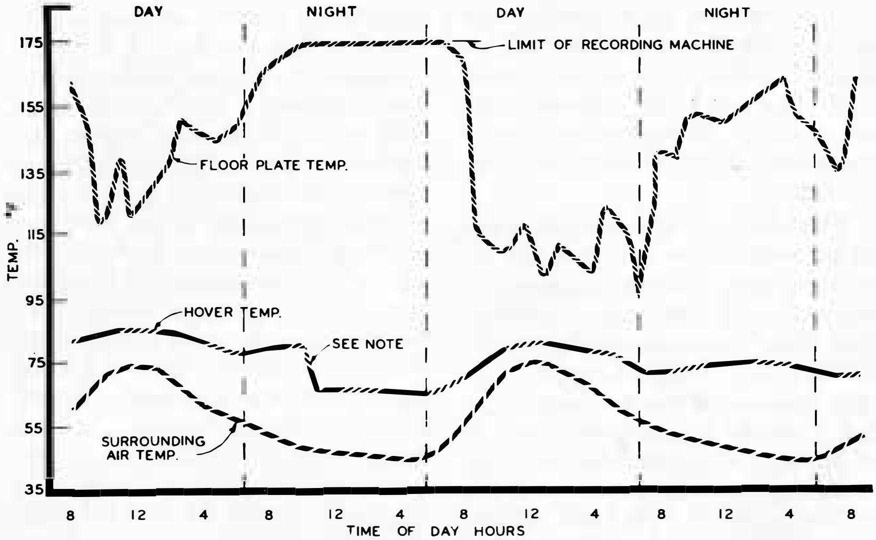


Figure 3. Typical daily cycle of temperatures obtained with capillary tube thermostat. Note dip in hover temperature, which occurred when chickens lying off the plate were returned to the hover.

gion separated from the chickens are not satisfactory. This is clearly shown by figure 3 which is a typical daily temperature cycle with a wafer thermostat on the surface of the floor plate.

When the chickens were active during the day, they were kept warm by the air in the hover. When the chickens went to rest on the floor plate, their bodies had an insulating effect. The heat from the floor plate did not affect the thermostat. The wafer thermostat, which reacts to warm air, demanded more heat. Eventually the plate got too hot for the chickens and they moved outside of the hover. They prefered to cuddle in chilly air than to lay on the hot plate.

Adequate Warmth

Adequate warmth can be maintained in two ways—by the production of sufficient heat and by the conservation of that heat.

To produce sufficient heat for average South Dakota conditions the soil heating cable should be spaced to provide a heating capacity of approximately 35 to 40 watts per square foot (watts/sq. ft.). The exact wattage will depend upon the average surrounding air temperature. For example, if air temperatures near the hover are expected to get as low as 10°F., 40 or 45 watts /sq. ft. is desirable. If the temperature will not go below freezing, 30 or 35 watts/sq. ft. would be satisfactory. The season of the year and the construction of the brooder house should be considered.

Heating capacities of less than 25 watts/sq. ft. or greater than 50 watts/sq. ft. are not recommended. In the latter situation heat cannot escape from the cable area rapidly enough. The heating cable will become charred and may even melt from excessive heat. (Although one set of cables melted during the experiments no fire damage was observed.)

The heat is of no value if it is not transferred to the chickens. An asbestos cement board is recommended for the plate because it transfers heat faster than any other common building board. Hard tempered 1/8-inch masonite is the next best thing but it should be used with caution if there is a chance that the surrounding air temperature will get as low as 20°F. Plywood retards heat flow 10 times more than asbestos board; therefore, it is not advisable except with a well built hover and where surrounding temperatures rarely go below freezing. No matter what type of surface is used, all heating units should have sufficient insulation beneath to insure that most of the heat will be transferred through the plate to the chickens.

Pouring a layer of sand over the heating cable after placing the floor plate in the brooder house and before attaching the top surface will increase the heat retaining capabilities of the brooder in case of power failure. However, this is an additional inconvenience in installation and the shifting weight makes the units hard to move. Therefore, this procedure is not recommended unless there is a large risk of power failure.

To conserve heat a hover should be placed over the floor plate. If a flat roof is not used and if a gabled roof to prevent roosting is preferred, a false ceiling of 3/8-inch plywood a foot above the floor plate is recommended. This type of hover confines the heat to a region immediately surrounding the chickens. Contrary to what was expected with the heating element below the floor, the temperatures near the false ceiling of the experimental brooder were, on the average, about 6°F. warmer than those near the floor. This data indicates that a gabled hover without a false ceiling would have its warmest air in a region where it would do little good. The underside of the false ceiling (or flat roof) should be painted with aluminum paint or better yet, lined with aluminum foil.

Heat loss calculations showed that the radiation heat loss to the false ceiling on a cold day amounted to approximately 260 watts if plywood was used, 149 watts for aluminum paint on plywood, and 14.9 watts for aluminum foil on plywood. Although the heat loss calculations did not account for all of the true heat loss, the temperatures tended to verify the ratios indicated by the above figures.

An example of the false ceiling is shown in figure 4 and in Plan 1. In cold weather, and at least for the first week of brooding, curtains of polyethylene or canvas should be hung to reduce heat loss around the edges of the brooder. If extreme cold (below 0°F.) is expected, the false ceiling should be covered with some form of blanket insulation, or supplemental heat in the form of ordinary light bulbs should be added.

Adequate Ventilation

Conservation of heat is, of course, the main consideration but, as conditions allow, the hover should have as much ventilation as possible. As the young chickens grow their demand for fresh air increases rapidly. Also, because the warm floor plate dries all of the droppings, evaporated moisture creates a humid atmosphere. This moisture condenses on the hover and/or the brooder house walls. Added to the problem is the dusty condition created by the chickens stirring the loose material on the surface of the floor plate.

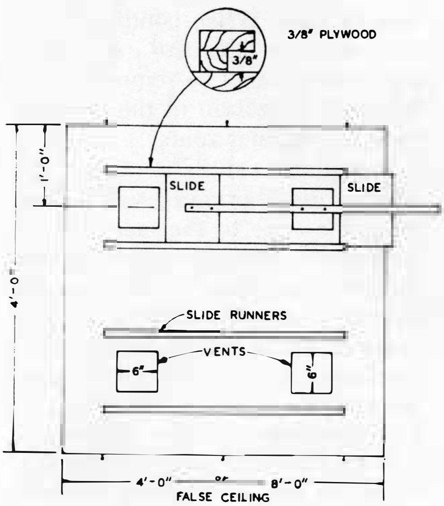
Although the data was not significant, chickens raised in ventilated experimental floor plate brooders showed a trend toward better efficiency and growth rate than those raised in unventilated brooders.

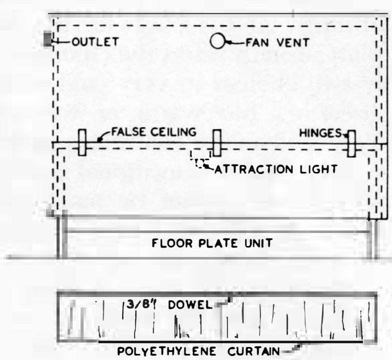
As soon as possible after brooding starts, the hover should be opened up to at least allow plenty of natural air movement through exhaust holes (see Plan 1). Even natural air movement does not seem quite adequate on warm days. A small inexpensive fan is recommended for positive air movement. These low cost fans ($2–3) obtainable from radio wholesalers or poultry equipment suppliers, consume only about 50 to 60 watts. They are so economical that every effort should be made to install one. Here, again, economy of the floor plate brooder permits the use of "deluxe" accessories. The power used to replace the heat lost by ventilation air is a small fraction of the overall cost of operation.

Temperature Transitional Zone

One advantage of the floor plate is that it produces heat over a large area, but unfortunately, it is uni-

Plan 1. Side view of hover and top view of false ceiling.





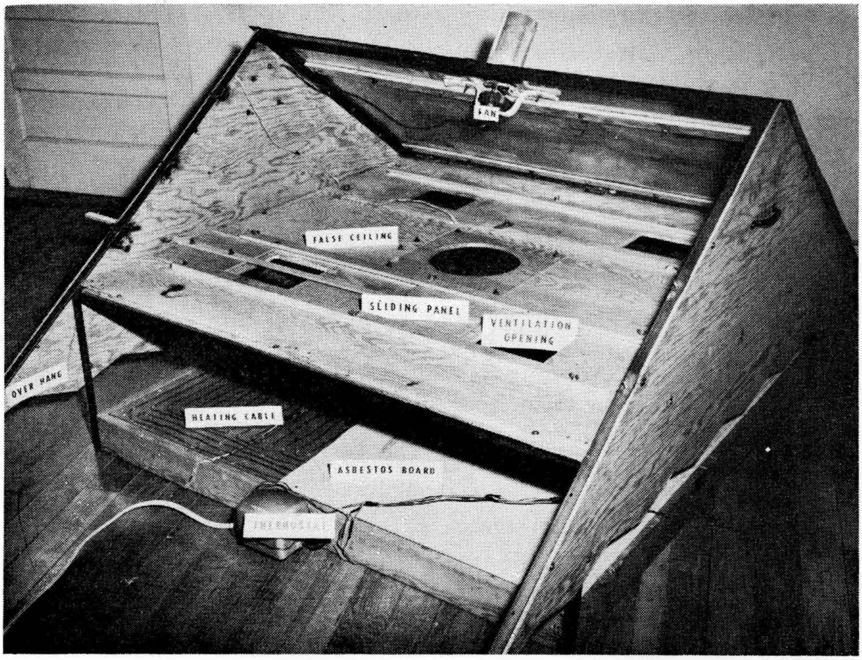


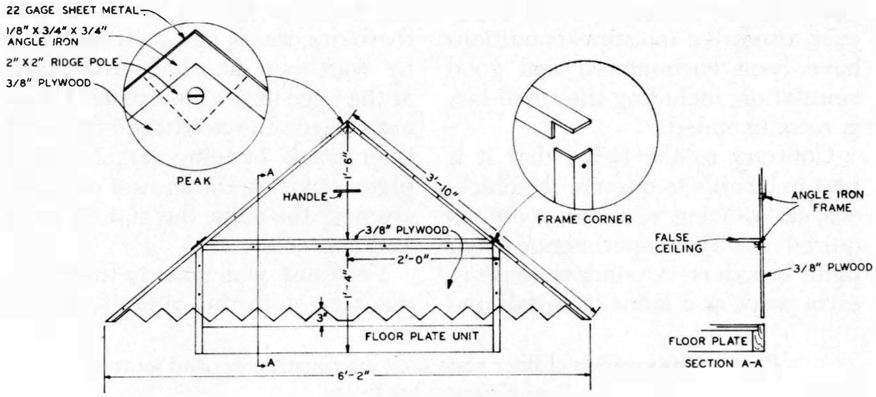
Figure 4. Hover of portable floor plate brooder with half of the roof removed.

form heat. No matter how accurately the temperature is maintained not all the chickens will be comfortable. Chickens prefer a region where they can choose their own comfortable temperature.

A brooder where the hover ends abruptly at the edges of the floor plate, usually offers the chickens only two choices in very cold weather—either too warm or too cold. Very seldom are conditions perfect. A temperature transitional zone can be achieved either by making the hover larger (in area covered) than the floor plate or vice versa.

Figure 4 and Plan 2 show the overhang used to secure the temperature transitional zones in the experimental brooders tested. Polyethelene curtains should be hung around the floor plate when conditions require maximum conservation of heat. When conditions permit, or as the chickens grow older, the curtains may be removed to allow full utilization of the temperature transitional zone.

Adequate ventilation also provides a distribution of temperature from the edge to the center of the floor plate. Attempts to secure nonuniform variation of the temperature by uneven spacing of the heat cable were not successful. The heating cable melted at the hottest point beneath the asbestos board and yet the temperature on the surface was still substantially uniform. For convenience in fabrication, uniform



Plan 2. End view and details of hover for floor plate brooder.

spacing of the heating cable is recommended.

Convenience

The primary consideration as far as convenience is concerned is that the floor plate and hover be separate units connected only by a plug that connects the floor plate to a power outlet on the hover (see Plan 3). Separated units are easier to handle and to clean.

Electricity should be brought by a drop cord into a surface mounted outlet box on the hover. As mentioned above, the floor plate unit should plug into this outlet. If a fan in the hover is used it should also be wired to plug into the outlet. An attraction light in the hover should be wired in parallel to the outlet box.

Raising the thermostat off the floor by the arrangement shown in Plan 3 makes it convenient for the operator and at the same time lifts it out of the manure.

Other typical convenience features are shown in figures 1 and 4 and Plans 1 and 2. Notice that the brooding area can be completely enclosed by polyethylene curtains when conservation of heat is of prime importance. Simple slides, adjustable from outside the hover, and the fan allow easy control of ventilation. Polyethylene side curtains can be removed easily to open up the hover and make a convenient temperature transitional zone under the overhanging flaps. The hinged flaps allow access to the interior of the hover and they can be completely opened when the chickens have grown to large size.

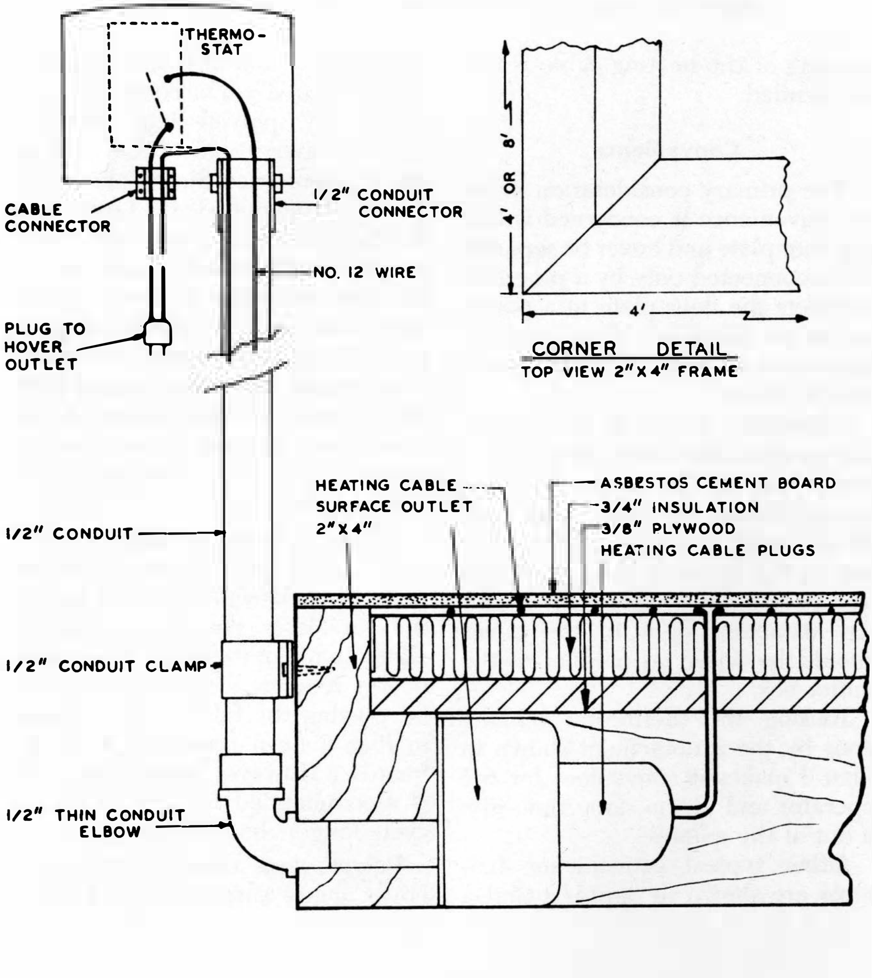
The sheet metal gabled roof prevents roosting. It is not necessary if the chickens will be moved before they are large enough to roost or climb on top of the hover. (Flat roof hovers may be simply constructed by placing the false ceiling shown in Plan 1 on a frame of 1″ by 4″ boards.) However, the gabled roof is recommended for any brooding cycle longer than four weeks.

Polyethylene may be used as a hover when surrounding air temperatures are extremely mild. However, excessive moisture conditions have been encountered and good ventilation, including the small fan, is recommended.

Contrary to the belief that it is best to be able to observe the chickens, no viewing windows were required for the experimental floor plate brooders. A window requires extra work and labor to install and it gets dirty within a few days. Furthermore, much can be determined by watching the chickens in view at the edge of the floor plate. If they are crowded around the edge with their heads hanging out, the floor plate is too hot. If there are no chickens near the edge, the plate is probably too cold.

For those who wish to follow the plans given in this bulletin, special

Plan 3. Cross section of floor plate showing construction and location of electrical hardware.



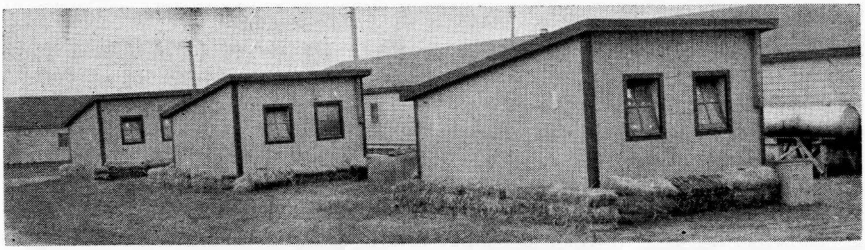


Figure 5. Portable shed-type houses used for comparison tests of brooders.

notice should be made of the method of mounting the angle iron frame on the end pieces of plywood. The iron can be secured to the plywood with machine screws and does not need to be welded, although it may be desirable. Notice that the angles to hold the false ceiling are mounted on the inside. Also the angle iron legs are mounted on the inside in such a manner as to fit around the corner of the floor plate. But the angles to support the roof are mounted on the outside. This allows the operator to assemble the false ceiling to the end panels with a minimum of effort, and also to secure the metal roof easily. Usually, by removal of four machine screws and one wood screw (into the 2x2″ rafter), the end panel can be removed.

Safe Wiring

In no case should two strands of heating cable touch or cross one another. If the cable does not have a non-heating lead (Underwriters Laboratory requires that they do) the cable may have to be placed through separate holes in the floor plate unit. No outlet box or connection should be left exposed on the floor plate. The chickens will work dust, moisture, straw, and similar objects into any small opening and create a shock hazard. The outlet box should be placed inside of the frame of the floor plate unit as shown in Plan 3.

EXPERIMENTAL PROCEDURE

For comparison purposes, heat lamps, a commercial resistance electric brooder and an experimental floor plate brooder were installed in identical unheated, shed type poultry houses shown in figure 5.

The heat lamp unit tested was a standard four lamp brooder with two lamps controlled by a wafer thermostat. For the first 3 or 4 weeks of each brooding cycle, a polyethylene hover was also used.

The commercial resistance electric brooder first studied was a standard 250-chick, 750-watt unit that was available commercially. In later experiments, a 1,000-watt unit was used, and during the colder weather a 250-watt heat lamp was also used to give a total heating capacity of 1,250 watts. All of these brooders had a resistance heating coil placed in the center of the hover approximately 10 inches above the chickens heads.

Each poultry house was equipped with a separate watt-hour meter which recorded the power consumed by the brooders.

The three types of brooders were compared on the basis of power consumption by the heating elements and the growth rate and feed efficiency of the chickens. The experimental floor plate brooder received particular attention with regard to improvement of design over previous experimental brooders.

The power consumption data are compiled in table 1. The floor plate brooder used, on the average, 36.1% of the power consumed by the heat lamps and 40.5% of the power used by the commercial brooder.

The comparative gain of the chickens is shown in table 2. Notice that the data indicate that the chickens raised in the floor plate brooder did not gain as fast during the winter brooding cycles as the chickens raised in the other brooders.

The data may have been influenced by lack of ventilation in the winter of 1958, and by the failure of the floor plate in 1959 when a plywood floor plate did not transmit heat rapidly enough. In fact, when the Poultry Department used the brooder during the winter months of 1960, the chickens raised in the floor plate brooder grew more rapidly and efficiently than those raised in the other brooders.

TABLE 2.
RATE OF GAIN COMPARISONS*
Weight of females at 8 weeks of age (in pounds)

	Winter	Spring
Floor Plate	1.29	1.56
Conventional Brooder	1.57	1.42
Heat Lamps	1.43	1.38

*Average of 2 years.

The chickens grew faster in the floor plate brooder during the warmer spring months. Also there was no difference in feed efficiency due to the brooders.

There was no significant difference in the mortality rate between the heat lamps and the floor plate brooder. In each test the conventional brooder had the least chickens die, except for the winter cycle of 1959 when a 750-watt brooder did not stay warm enough.

The floor plate brooder tested in the first trial in 1956 was a prototype of the brooder used in experiments at Louisiana State College. It failed to produce and conserve enough heat during February weather conditions in South Dakota. During the months of April

TABLE 1. POWER CONSUMPTION COMPARISONS

	1956 (4 weeks)	1958 (8 weeks)		1959 (8 weeks)	
	April-May	Feb-Mar	Apr-June	Feb-Mar	Apr-June
Floor Plate	142	294	173	486	217
Conventional Brooder	264	766	557	932	870
Heat Lamps	429	950	453	1050	929

and May chickens were successfully brooded in it.

The second experimental model had twice the heat capacity (50 watts per square foot) and an insulating false ceiling. It withstood temperatures as low as -5°F. but lacked ventilation. The growth rate of the chickens raised in it was lower than the growth rate of the chickens raised with the heat lamps and the conventional brooder (see table 2).

The third experimental model had adequate ventilation provided by a small fan. It was also equipped with an automatic temperature recorder that recorded 17 different temperatures once an hour, every hour for four weeks. In this third comparison the chickens raised in the well-ventilated floor plate brooder had a slightly faster growth rate than those raised under heat lamps or in the commercial brooder (see table 2).

The fourth experimental brooder, which is shown in figure 4 and upon which the plans in the bulletin are based, was originally installed in January 1959 with a plywood plate surface to test the contention of other experimenters that plywood was fully as satisfactory as asbestos board. As mentioned before, the plywood could not conduct heat fast enough. The day the chickens arrived the outdoor temperature went down to -12°F. Surrounding air temperature (in the brooder house) was 0°F. and the temperature in the hover went lower than 32°F. Most of the chickens eventually died and the remainder had stub feet as evidence of frost bite. The plywood was replaced immediately with asbestos board, under similar conditions two days later the hover was maintained 30° warmer.

The only inconvenience encountered with the brooder was the location of the thermostat (see figure 4). This was changed to the arrangement shown in Plan 3.

The same brooder was used again during April, May, and June of 1959. It gave satisfactory service with a minimum of maintenance. Growth of the chickens was more than that of the chickens raised in the other brooders.

Table 3 shows the comparative cost of brooding by the three electric methods used in this research. Prices were taken from (1959) catalogs and price listings. The cost of electricity was assumed to be 2 cents per kilowatt hour. The life and upkeep of the brooders was assumed to be the same. Note that, if only one brooding cycle is planned, heat lamps cost less. If the brooder will

TABLE 3. COST COMPARISON OF ELECTRIC BROODERS

	Floor Plate	Conventional	Heat lamps
Original cost	$67.32	$46.50 to 64.50	$19.45
Average power cost 8 wk. cycle	6.10	15.06	16.90
Total cost one 8 wk. cycle	73.42	61.56 to 79.56	36.35
Total cost five 8 wk. cycles	97.82	121.80 to 139.80	103.95

be used for more than five cycles, the floor plate brooder is the least expensive. The prices quoted were for new material and a farmer can usually cut costs by utilizing many odds and ends around the farm. Notice that every $10 savings means one less cycle for the brooder to pay for itself.

SUMMARY

The floor plate brooder is a practical brooder for South Dakota farmers. It definitely makes more efficient use of electric power. During the warmer weather it is as good as other types of commercial brooders in regard to growth rate and feed efficiency of the chicks brooded with it. Extra precautions have to be taken to insure adequate warmth during extremely cold weather. The plate brooder can be built easily and dismantled rapidly to utilize a small storage space.

Six basic requirements should be observed in the construction of a floor plate brooder. These requirements are:

1. Accurate thermostatic control.
2. Adequate heat.
3. Adequate ventilation.
4. Temperature transitional zone.
5. Convenience.
6. Safe wiring practices.

LIST OF MATERIALS FOR EXPERIMENTAL FLOOR PLATE BROODER

Hover Frame: 30′ of 1/8″ x 3/4″ x ¾″ Angle iron
Floor Plate Frame: two 2″ x 4″ x 8′ or four 1″ x 4″ x 8′
Ridge Pole: one 2″ x 2″ x 4′
False Ceiling, Bottom of Floor Plate, Ends, Slides, Slide Connectors, Slide Runners: two 4′ x 8′ x 3/8″ plywood
Floor Plate Insulation: one 4′ x 4′ x 25/32″ insulation board
Top of Floor Plate: one 4′ x 4′ x 1/8″ asbestos board
Curtains: 10 sq. ft. of polyethylene or canvas
Curtain Rods: two 1/4″ x 4′ Dowels
Heat Cable: 800 watts or more (5 watts per foot recommended)
Outlet Boxes (surface mount): two
Plugs: two 2 prong, one 3 prong
Conduit: 3′ of 1/2″ thinwall
Wire: 10′ of #12 single strand; 15′ of #12 UF Double strand with ground; 10′ of #14 Double strand rubber covered (lamp cord)
Thermostat: Capillary tube type
Surface mounted attraction light
Fan
Conduit Clamp
Conduit 90° Box Connector
Cable Connector
Hinges: six
Handles: two
Screws
#3 Insulated Staples
3/16″ Machine Bolts