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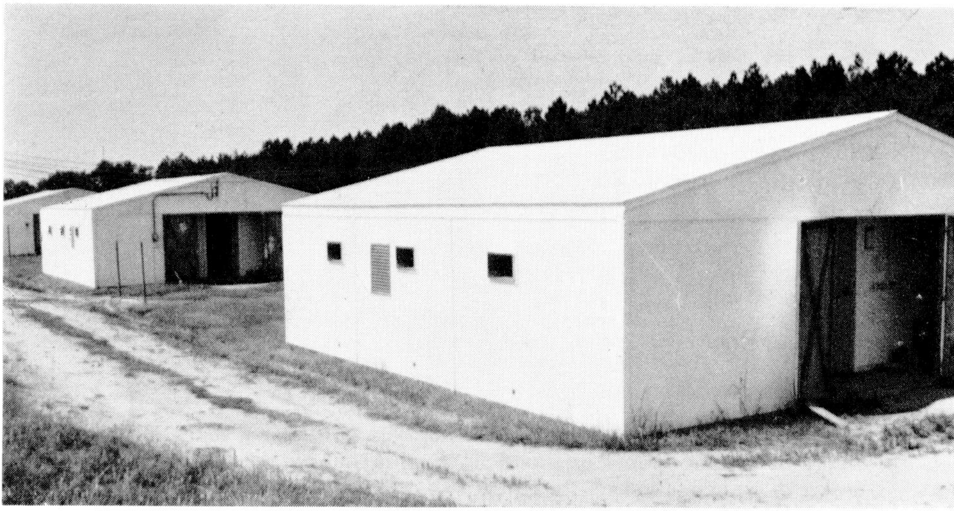
PSYCHROMETRIC CHAMBERS for POULTRY



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Psychrometric Chambers for Poultry

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IN THE PAST, layers and broilers have been selected and managed according to their adaptation to prevailing climatic conditions. Research results indicate that animal production is affected by environmental variation. Since selective environments can be produced by mechanical means, a completely new approach is open to poultry husbandry. Existing climatic conditions with undesirable extremes no longer need be controlling factors in selecting and managing poultry.

Before poultry production under controlled environment can be accepted as practical, the effects of environment on such factors as weight gain, feed efficiency, egg production, and animal health must be determined. The practical limits of temperature, humidity, air movement, ventilation, and light must be established, along with the economic value of environmental control. For such investigations psychrometric chambers are necessary. A psychrometric chamber is designed to permit both control and measurement of various desired environmental factors.

Psychrometric test facilities for poultry were constructed at the Agricultural Experiment Station of Auburn University. These test facilities were designed and erected to provide reasonable assurance of statistically reliable results. This required that the chambers be sized to handle sufficient birds to reduce individual variation and that there be enough chambers to provide replications with simultaneous treatments. The chambers were made as identical as possible with individual controls for each chamber, thereby allowing random selection of chambers for different treatments and reducing chamber variations as much as possible.

Twelve chambers are located inside two similar wood frame buildings, (see cover) measuring 30 × 32 feet with an 8-foot ceiling. The floor consists of a 4-inch reinforced concrete slab sloped to a floor drain in the center of each chamber. Side walls are framed with 2 × 3-inch studs spaced 2 feet on center and covered on the outside with ½-inch Homasote. The roof is framed with wood trusses spaced 2 feet on center, decked with ½-inch Homasote, and covered with a roll roofing surfaced with a white aggregate. The ceiling is finished with 1/8-inch Masonite. Exterior walls are painted with three coats of a high gloss exterior white paint to reflect solar energy.

DESCRIPTION of CHAMBERS

The walls and ceilings of the chambers, Figure 1, are made separate from and independent of the enclosing structure. A 3-foot-wide walkway is provided completely around the chambers permitting free access between the chamber walls and exterior walls of the building. A 3′-0″ × 6′-8″ insulated door opens from each chamber into a 4-foot-wide center hall.

Each chamber measures 8 × 10 feet and has a 7-foot ceiling. The walls are framed with 2 × 4-inch studs spaced 16 inches on center and the ceiling is framed with 2 × 6-inch joists spaced 12

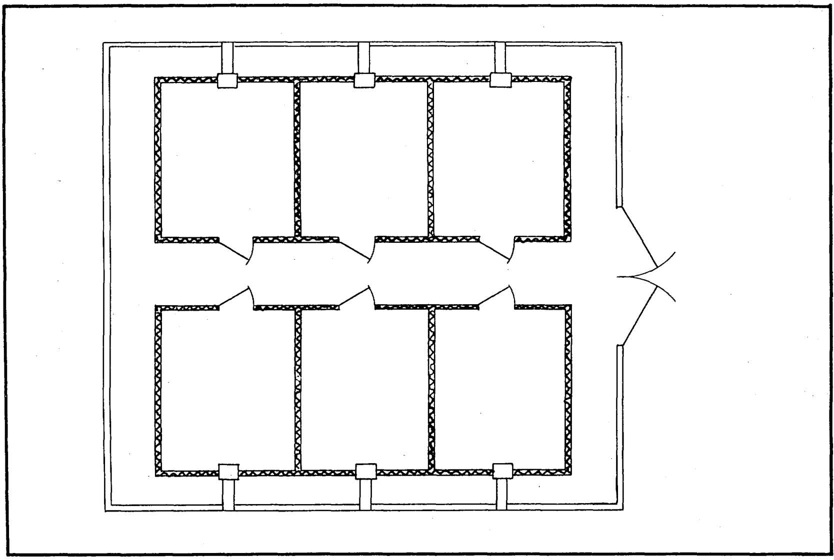

FIG. 1. This floor plan shows arrangement of chambers within the buildings.

inches on center. Both walls and ceiling are insulated with 3-inch thick fiberglass batts protected on both sides with a vapor barrier of cloth reinforced aluminum. The walls are surfaced with 1/8-inch Masonite and painted with three coats of a white enamel paint. Interior walls of the chambers are covered with a 4-mil clear polyethelene film to prevent accidental soiling.

VENTILATION EQUIPMENT. Each chamber is equipped with a centrifugal blower having a capacity of 60 c.f.m. at 0.1-inch static pressure. The blower, mounted on the rear wall, introduces incoming ventilation air into the air stream of the heat exchanger. A manually operated slide damper on the intake side of the blower regulates the volume of ventilation air.

HEATING, COOLING, AND HUMIDIFYING. Heat is provided by a single 3,000-watt, 220-volt coil heater, Figure 2, placed in the discharge opening of the temperature control unit. Refrigeration is

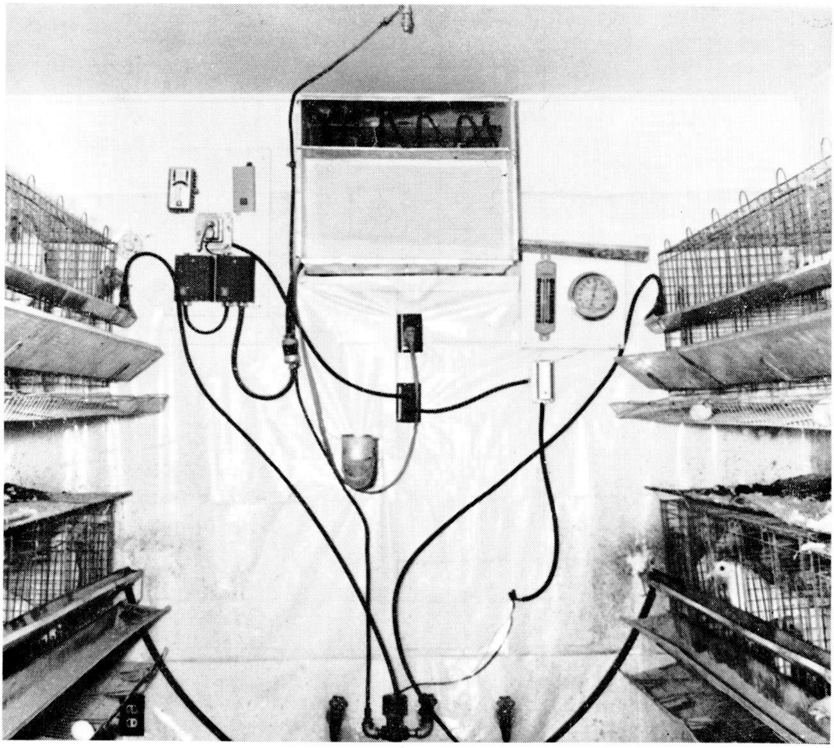

FIG. 2. Shown here is the heat exchanger with air filter, electric heating coils, humidifier nozzle, and controls that are provided in each chamber.

provided by a Gibson Model No. C91128 heat pump rated at 10,000 B.t.u. The cold coils act as condensation surfaces and effectively remove water vapor from the atmosphere. Ice formation on the cold coils is controlled with a reverse flow solenoid valve. This valve, an intergral part of the heat pump, controls the flow of hot compressor gases through the coils and effectively flushes away any ice. A mist spray nozzle connected to a water line serves as the humidification source for the chamber. The nozzle, a model No. BC-2, is manufactured by the Delavan Corporation and is rated at 1.27 gallons per hour at 50 p.s.i. ,

Control System. The control system, Figure 3, is powered by a 25-volt, 60-cycle circuit. A Minneapolis-Honeywell (M-H) transformer Model No. AT72 is used as the power source. The compressor and the electric heater are controlled by M-H Model No. R847B switching relays. These relays in turn are controlled

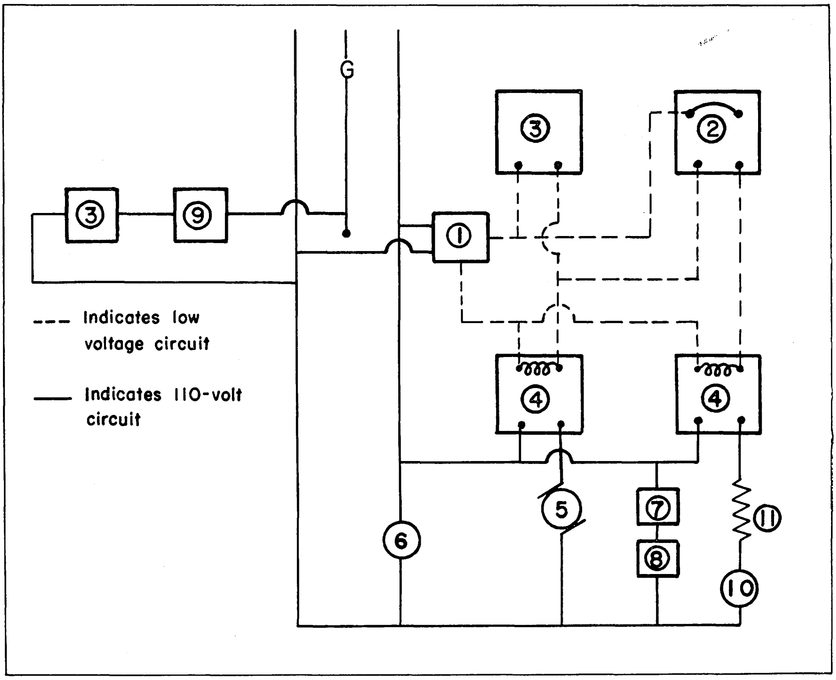

FIG. 3. Components of the control system are shown by this wiring diagram: (1) transformer, AT72 (M-H); (2) thermostat, T42K1043 (M-H); (3) humidistat, H63A (M-H); (4) relay, R847B (M-H); (5) refrigeration compressor; (6) fan motor, 220-volt; (7) ambistat, L4008C (M-H); (8) heat pump solenoid valve; (9) water valve, V4019A (M-H); (10) temperature switch, S43B, general controls; and (11) coil heater, 3,000 watts, 230 volts.

by an M-H T42K1043 thermostat and an M-H H63A humidistat. The thermostat differential is 1° on the heating stage, 3° on the cooling stage, and 1° between stages. The heating stage of the thermostat is wired in parallel to the humidistat. This allows either temperature or humidity to actuate the refrigeration compressor. Water flow to the humidifier nozzle is regulated by a 110-volt, M-H V4019A water valve, which is controlled by an M-H H63A humidity controller. Ice formation on the cooling coils is contolled by an M-H L4008C remote bulb temperature controller. The remote bulb is placed about 1/8 inch from the front face of the cooling coils.

The illumination in each chamber is supplied by a 40-watt incandescent bulb located in a 110-volt outlet in the center of the ceiling. This light is controlled by a manual and an electric time switch placed in series.

DUST CONTROL. A 10 × 24-inch air filter is located in the intake side of the heat exchanger. The filter, consisting of 2-ply American Filter Company type S filter paper, is held in place by air pressure against a ¼-inch hardware cloth.

EQUIPMENT FOR BIRDS. Laying hens are housed in individual 10-inch wire cages. These are mounted to form four rows of 11 cages, two rows one above the other on each side of the chambers. Water troughs are mounted on the cage front to provide continuously flowing water to each cage. Feed is also provided at the front of each cage and covers are available to cover either the continuous water or feed troughs of cages to permit individual feed or water consumption data to be collected. Broilers are raised on the floor or in five-tier battery cages, which can be moved into the chambers. The floor birds are fed and watered with conventional waterers and feed trough feeders.

COSTS. In view of the degree of environmental control possible, the costs were relatively low. This was largely the result of using standard stock equipment and controls. The heat exchanger was a standard 1-ton window heat pump air conditioner that was converted for regulation by commercialy available industrial controls. The building and chambers were constructed using standarized framing methods and low cost building materials. The cost per chamber fully equipped was approximately $2,000, including labor and materials.

PERFORMANCE of EQUIPMENT

The chambers were completed in August 1960, and operated and checked until January 1, 1961, when the first series of tests involving laying poultry was begun. During this period of equipment testing and during the subsequent 1½-year formal research period, the equipment performed according to design expectations. Temperature was held to a 4°F differential at the constant design levels of 50 to 100°F. Floor to ceiling temperature stratification was held to less than 1°F as a result of the turbulence introduced into the chamber air by the air stream of the heat exchanger. This air stream caused an average air velocity in the cage of 40 f.p.m.

Relative humidity was maintained at constant 60 per cent with a differential of 5 per cent. The ventilation system provided 44 c.f.m. or approximately 4.7 air changes per hour per chamber. This rate provided air exchange at the rate of 1 c.f.m. per caged bird. Continuous air flow through the filter averaged 270 c.f.m., or 29 recirculations per hour. The filter paper was replaced every 12 to 24 hours, depending on the birds and the temperature, to prevent a build-up of static pressure in the heat exchanger. Occassional equipment failure was overcome with a spare heat exchanger, which was readily substituted for inoperative equipment.

CONCLUSIONS

The chambers proved to be an excellent tool for biological research. The costs were relatively low as the result of utilizing standardized commercially available materials, equipment, and controls. The performance was satisfactory with relatively small differentials.

During the 1½ years of operation, many changes were made in the original design and improvements are continuing. They will be described and discussed in a later publication.