

ENVIRONMENTAL CONTROL IN POULTRY HOUSES

Eng. J.H.M. Cremers

Production	7
Automated control system functions	8
A. Environmental conditions	8
B. Tight control	13
C. Feeding and Water supply	14
D. Production	15
Systems set up	22
Index	29

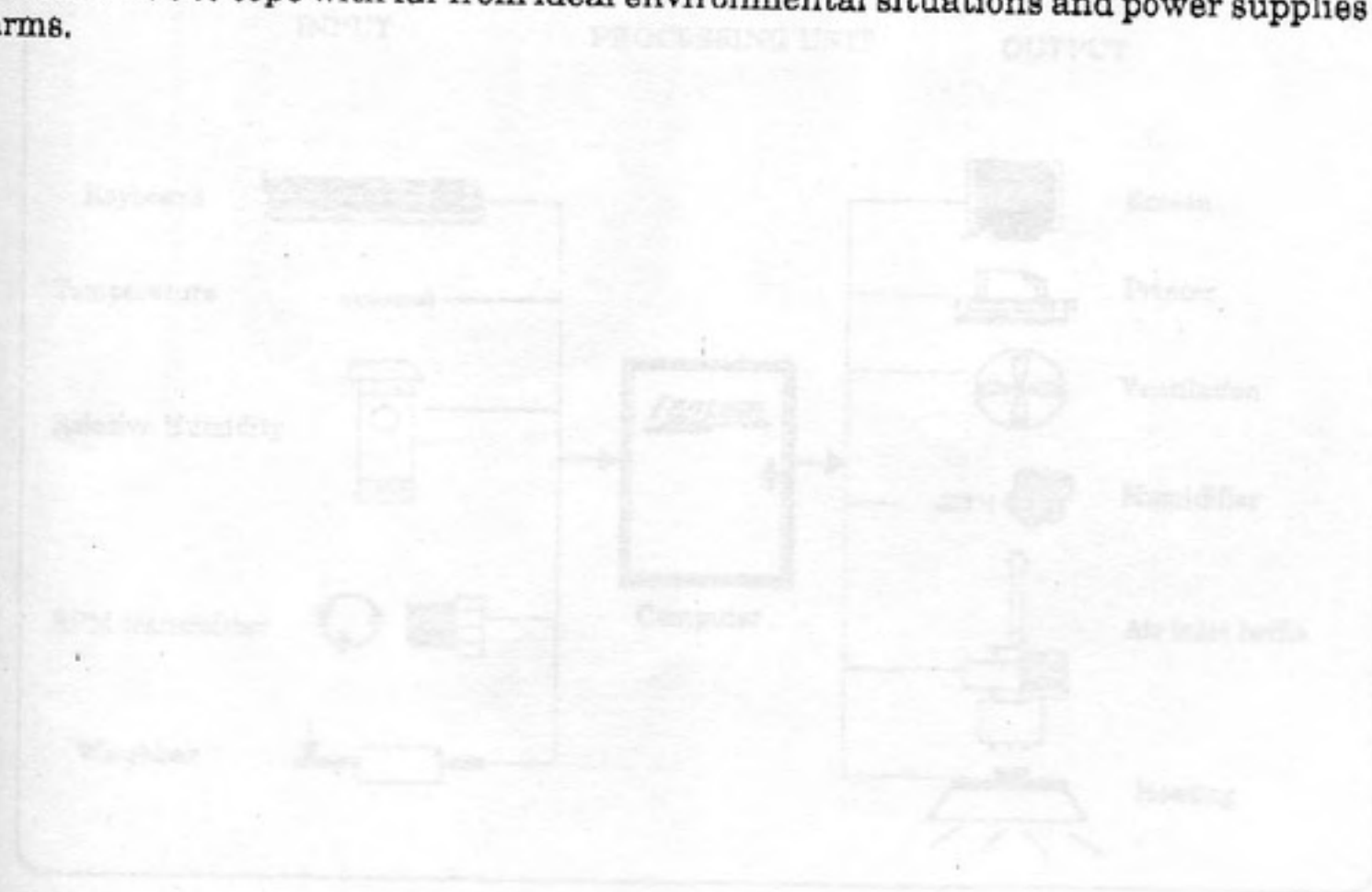
INTRODUCTION

Although "Computerised Process-Control" appears to be more applicable to, for example, petrochemical plants, than to poultry houses, in today's modern poultry business so many technical processes take place which can and should be controlled and optimised, that it is almost impossible to do this manually.

When speaking of computers in this context, we do not mean the widely spread PC's or larger office-computers. They are developed mainly for storage and processing enormous quantity of data. Typically they do not use very sophisticated programs but they have large memory-capacities. Input is mainly provided through the keyboard and output through screen and/or printer. They are developed for relatively short running times.

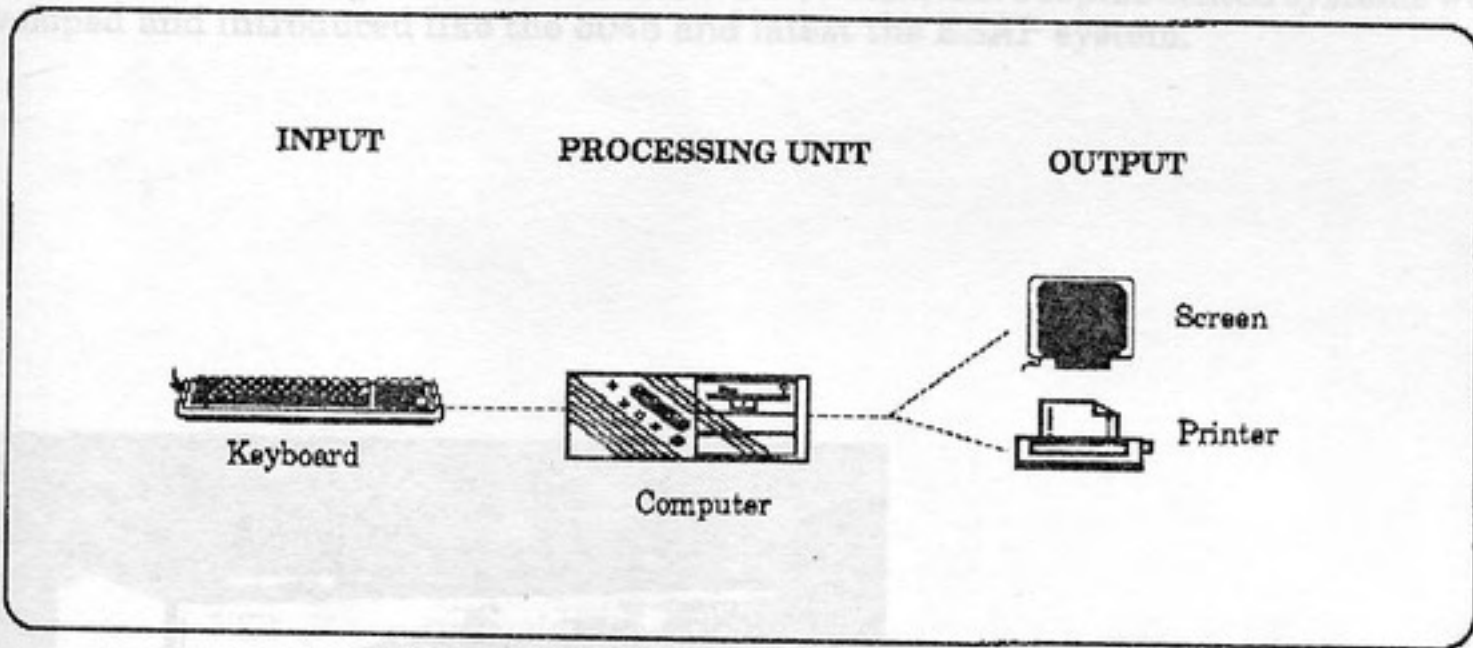
For example, processcomputers in poultry houses have to run full 8760 hours per year. Even then, they need a much better reliability-record, because failures cause far more damage than for e.g. PC's used for wordprocessing or bookkeeping. Also the system set up of poultry computers has to be totally different from PC's. Although mostly a keyboard, screen or display and a printer can be found, they are of secondary importance for poultry computers. The most important inputs are collected continuously by the process computers themselves through sensors for e.g. temperature, humidity, weight, waterflow etc. And after processing all the inputdata, the outputs are technical control signals for e.g. fan speed, baffle openings, light intensity etc, etc.

So typically, poultry-computers are specially developed for this application; they usually have a highly sophisticated program and a small memory-capacity. Besides, their construction has to cope with far from ideal environmental situations and power supplies on farms.

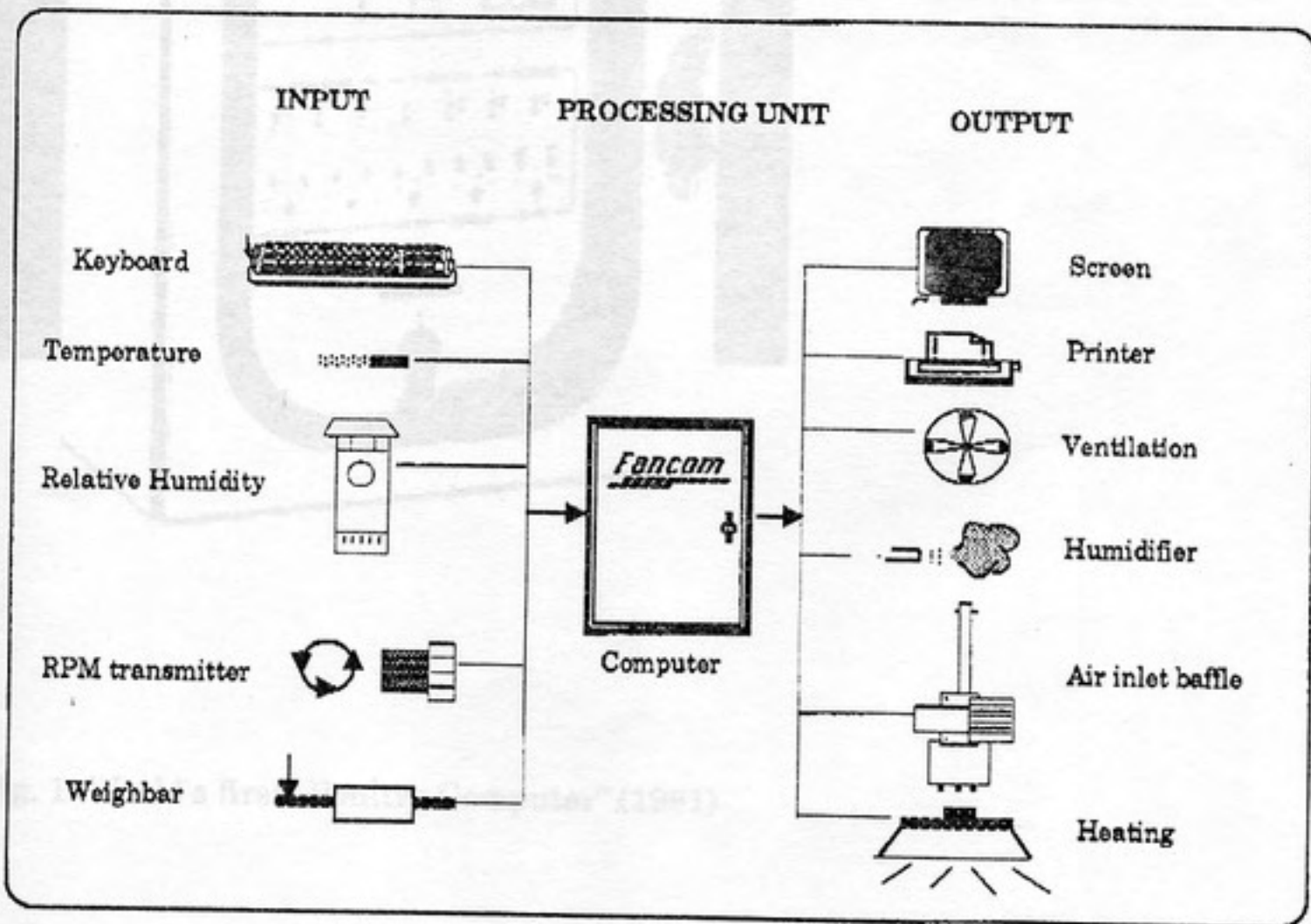


Personal Computers, e.g.:
*** Management**

- * Financial**
- * Wordprocessing**



Process Computers, e.g.: *** Climate control**
*** Dosage**
*** Safe guarding**



The first real "Poultry Computer" was Fancom's 1045 (see picture 1) which was introduced in 1981. This system primarily dealt with environmental climate control and also provided some feed- and light control functions. Since then, more sophisticated systems were developed and introduced like the 3045 and latest the ESAP system.

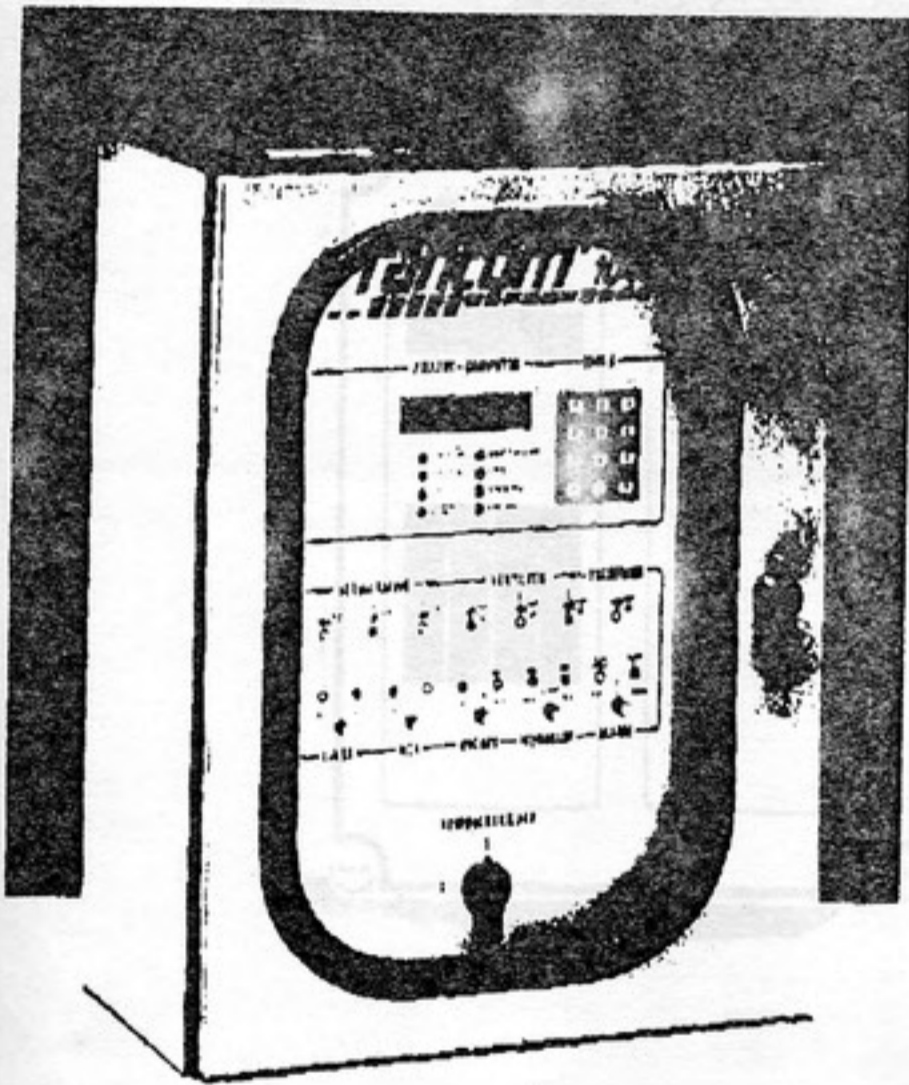


Fig. 2: ESAP (1987)

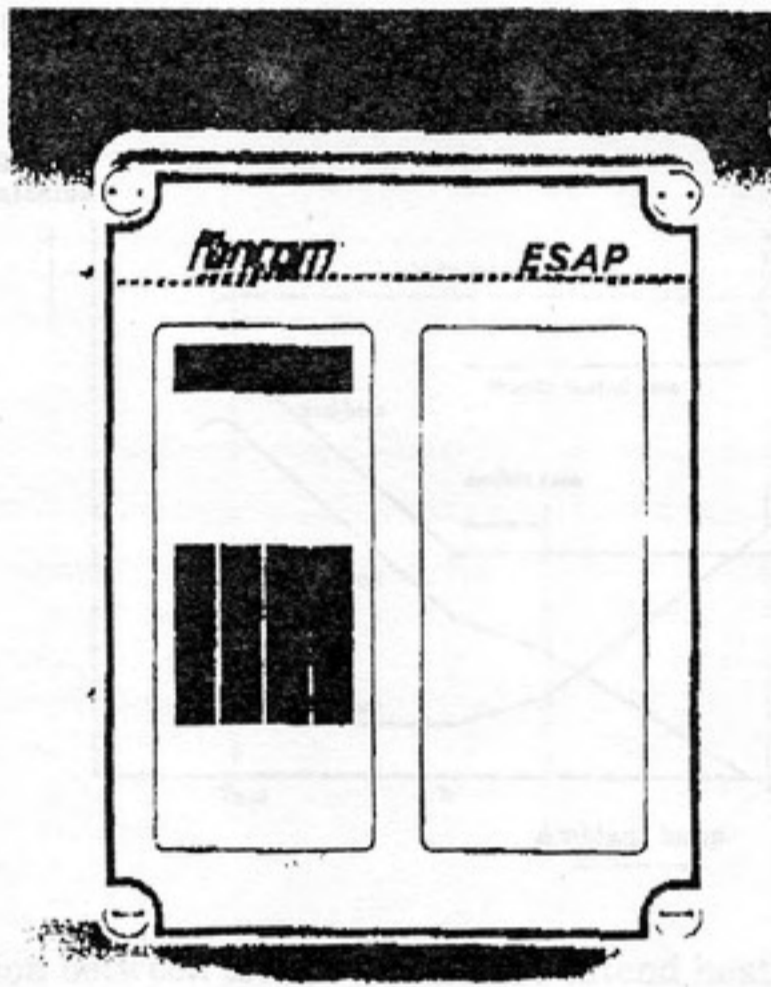
Fig. 1: World's first "Poultry Computer" (1981)

COMPUTERISED CONTROL SYSTEM FUNCTIONS

1. Environmental conditions

All living creatures have a constant metabolic process which consumes and breaks down food and respired oxygen and supplies the body with heat, CO_2 and water. To avoid a constantly increasing body temperature the produced heat has to be emitted. Every body has a built-in physiological control mechanism, to determine, depending on the environmental conditions, which part of the heat is emitted as sensible heat (convection, radiation and transmission) and which part as latent heat (evaporation of the skin and via respiration).

The relation shown in fig.



shows in general, of an animal is

Fig. 2: ESAP (1987)

Fig. 3: Relation between room temperature and heat emission of an animal

The crucial point is: T_c = Critical temperature

When the room temperature drops below the T_c , the heat-loss of the animals body will increase and therefore also the feed consumption will increase considerably, in order to keep up the body temperature. In this case a considerable part of the consumed feed is used for "heating". In most circumstances, the cost of heating by means of fuel is much lower than by means of animal feed.

For example in Holland:
Animal feed \pm / 0.08 MJ
Heating oil \pm / 0.010 MJ

COMPUTERISED CONTROL SYSTEM FUNCTIONS

A. Environmental conditions

All living creatures have a constant metabolic process which combines and breaks down food and respired oxygen and supplies the body with heat, CO_2 , fluid etc. To avoid a constantly increasing body temperature the produced heat has to be emitted. Every body has a built-in physiological control mechanism, to determine, depending on the environmental conditions, which part of the heat is emitted as sensible heat (convection, radiation and transmission) and which part as latent heat (evaporation via skin and via respiration).

The relation between total, sensible and latent heat emission in general, of an animal is shown in fig 3.

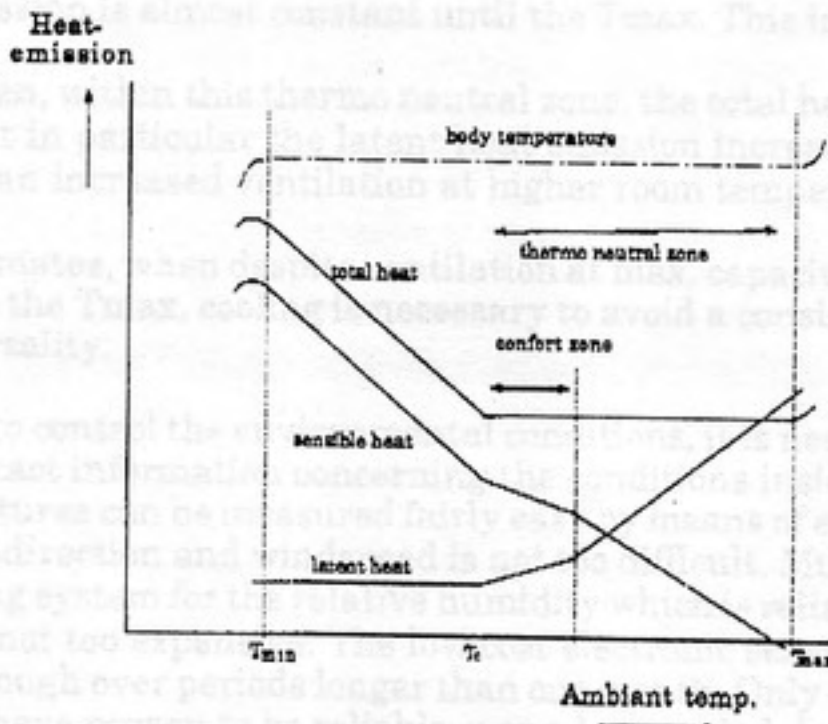


Fig 3: Relation between total, sensible and latent heat emission of an animal

The crucial point is : T_c = Critical temperature.

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For example in Holland:

Animal feed $\pm f$ 0.05/MJ

Heating oil $\pm f$ 0.015/MJ

To avoid extra feed consumption or extra heating, the housing ventilation should be brought back to the lowest possible level, when the room temperature nears T_c . The lowest possible level of ventilation is determined by the max. acceptable level of Relative Humidity, CO_2 and NH_3 . In practice, mostly the NH_3 level is the limiting factor. (max. 25 - 30 PPM). Today, low priced and reliable NH_3 sensors do not exist. So, in most control systems a minimum ventilation level is introduced to maintain the maximum Relative humidity - CO_2 - NH_3 levels. When, because of the minimum ventilation, the room temperature falls below the T_c of the animals, the heating system has to be switched on.

It is clear, that to avoid waste of heating energy or feed and to avoid a bad atmosphere for the animals a very accurate and flexible min. ventilation control is of high importance.

Fig. 3 also shows, that, when the room temperature increases over T_c , the total body heat emission is almost constant until the T_{max} . This is called the "Thermo-neutral zone".

Even when, within this thermo neutral zone, the total heat emission is constant, it is clear that in particular the latent heat emission increases sharply. This causes the need for an increased ventilation at higher room temperature.

In hot climates, when despite ventilation at max. capacity, the room temperature approaches the T_{max} , cooling is necessary to avoid a considerable loss of production or even mortality.

In order to control the environmental conditions, it is necessary to have a continuous flow of exact information concerning the conditions inside and outside of the house. Temperatures can be measured fairly easy by means of electronic sensors. Also sensing wind-direction and windspeed is not too difficult. Much more difficult is to find a measuring system for the relative humidity which is reliable over a longer period and which is not too expensive. The low cost electronic sensors are neither accurate nor stable enough over periods longer than one month. Only dry and wet bulb measuring systems have proven to be reliable over a long period, but these also require regular maintenance. This system can only be applied in combination with a computer, which has to be programmed to calculate the relative humidity from the dry bulb and wet bulb temperature.

Because of internal and external influences, the environmental conditions in the house fluctuate continuously. This means that the control system also has to be able to change the ventilation, heating or cooling capacity continuously. For example, by switching on/off groups of fans the airflow through the house can be regulated, or at minimum ventilation levels to regulate the speed of the fans. At the same time the air intake has to be controlled.

For example, the environmental control systems for typical Dutch poultry houses are shown in:

Fig. 4: For mechanical ventilated houses

Fig. 5: For natural ventilated houses.

Characteristic for this system are the four air inlet baffles, each of them controlling by means of its own temperature sensor, a certain zone of the house. Besides the zone temperature also outdoor temperature, wind velocity and wind direction can be taken in account. E.g. if with a certain baffle opening, the wind velocity increases, this baffle(s) will be closed a certain percent (depending on the wind velocity) so to avoid more cold air entering and even to prevent the temperature at the sensor dropping. With this zonal ventilation system regularly the temperature difference between the four sensors do not exceed 1 - 1,5 °C.

While mechanical ventilation always means a negative pressure in the house, it has to be considered as one system, to be controlled on basis of the average temperature of the four sensors. This means automatically, that the total exhaust capacity changes linear with the sum of the air inlet opening, thus giving an almost constant average airspeed in the inlets.

All types of fan control systems are applicable. However we prefer a system, where at least the first 50% of fan capacity has a stepless speedcontrol and the rest of the fans are switched on/off in 3-6 banks with raising house temperature.

Fig 4: Mechanical ventilated house

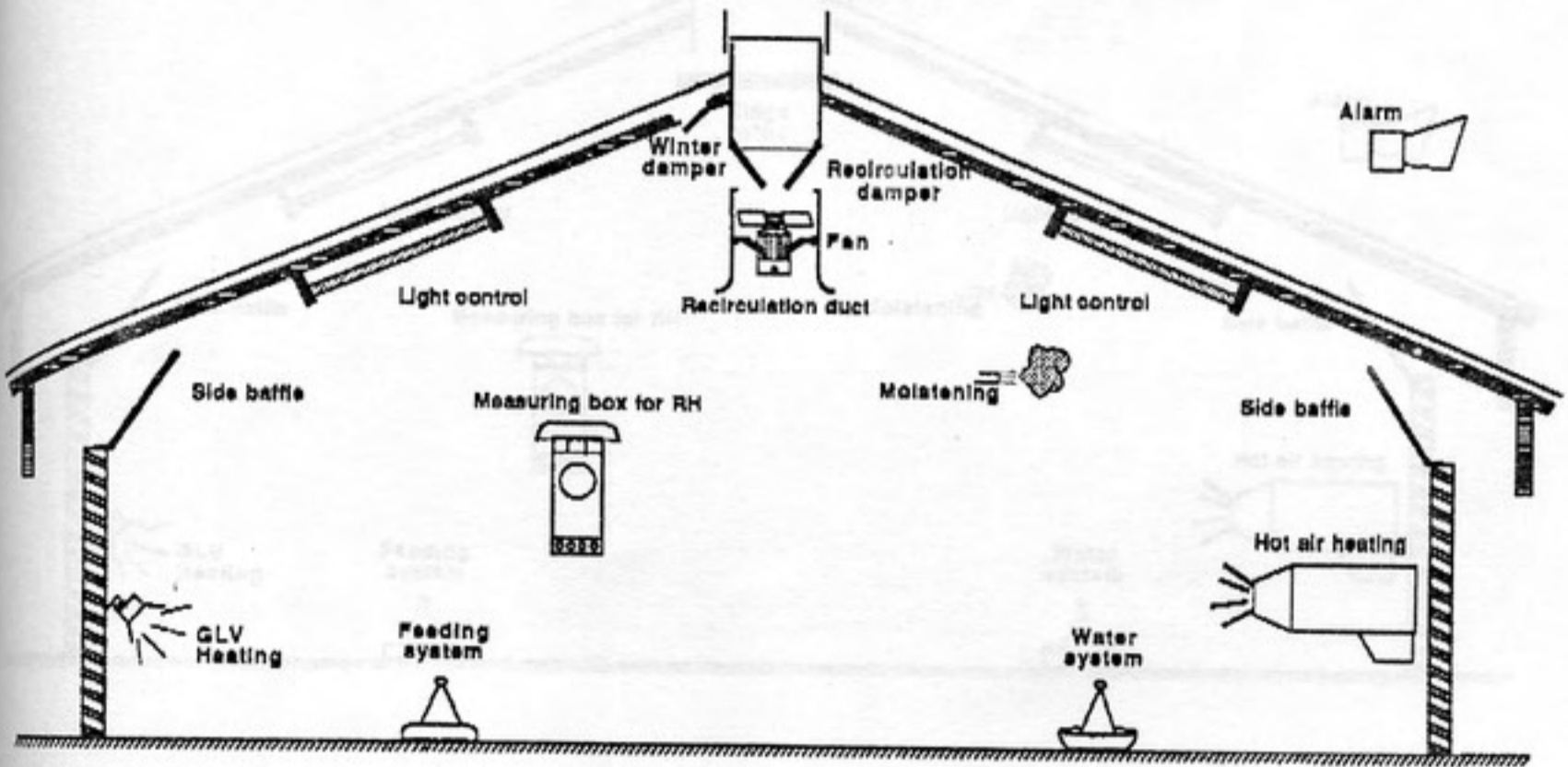
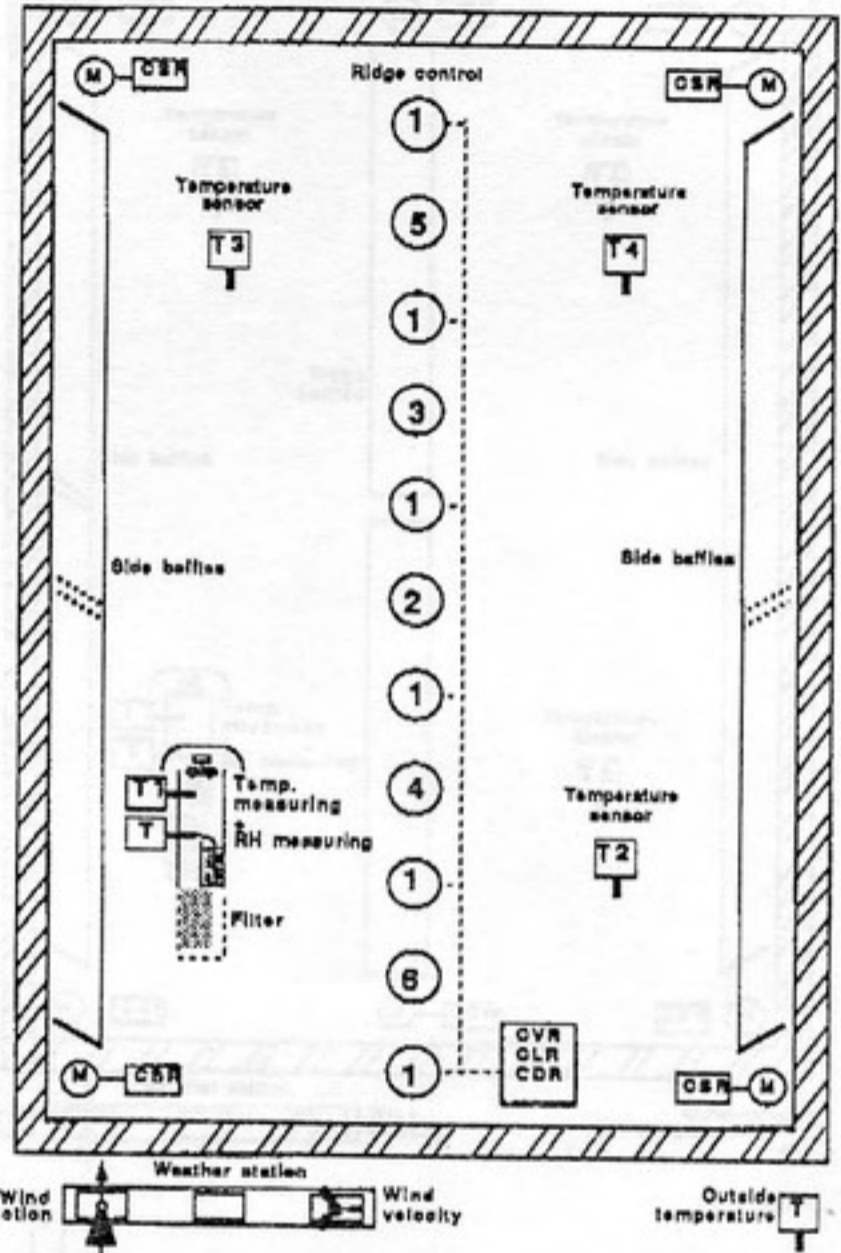
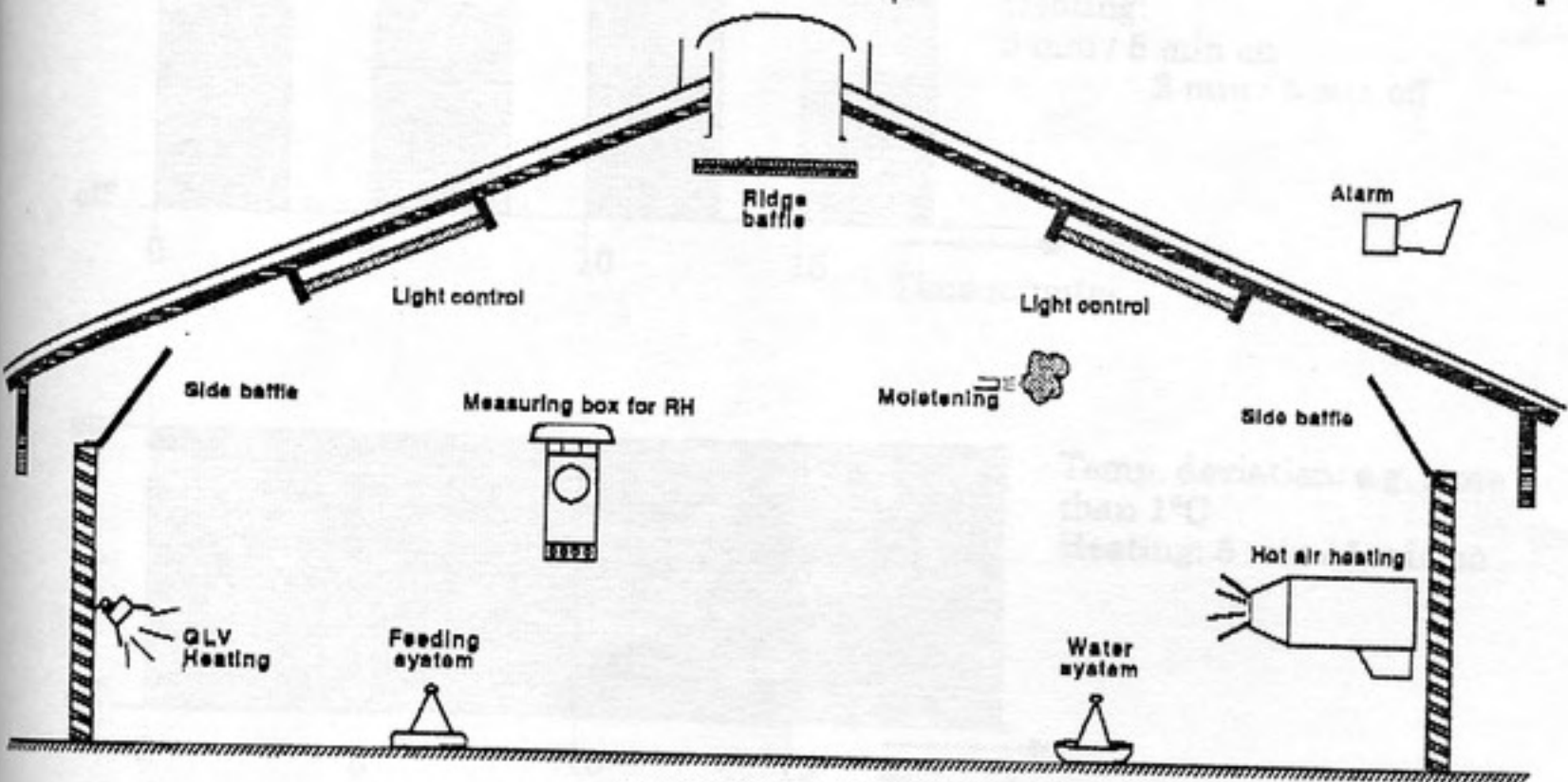
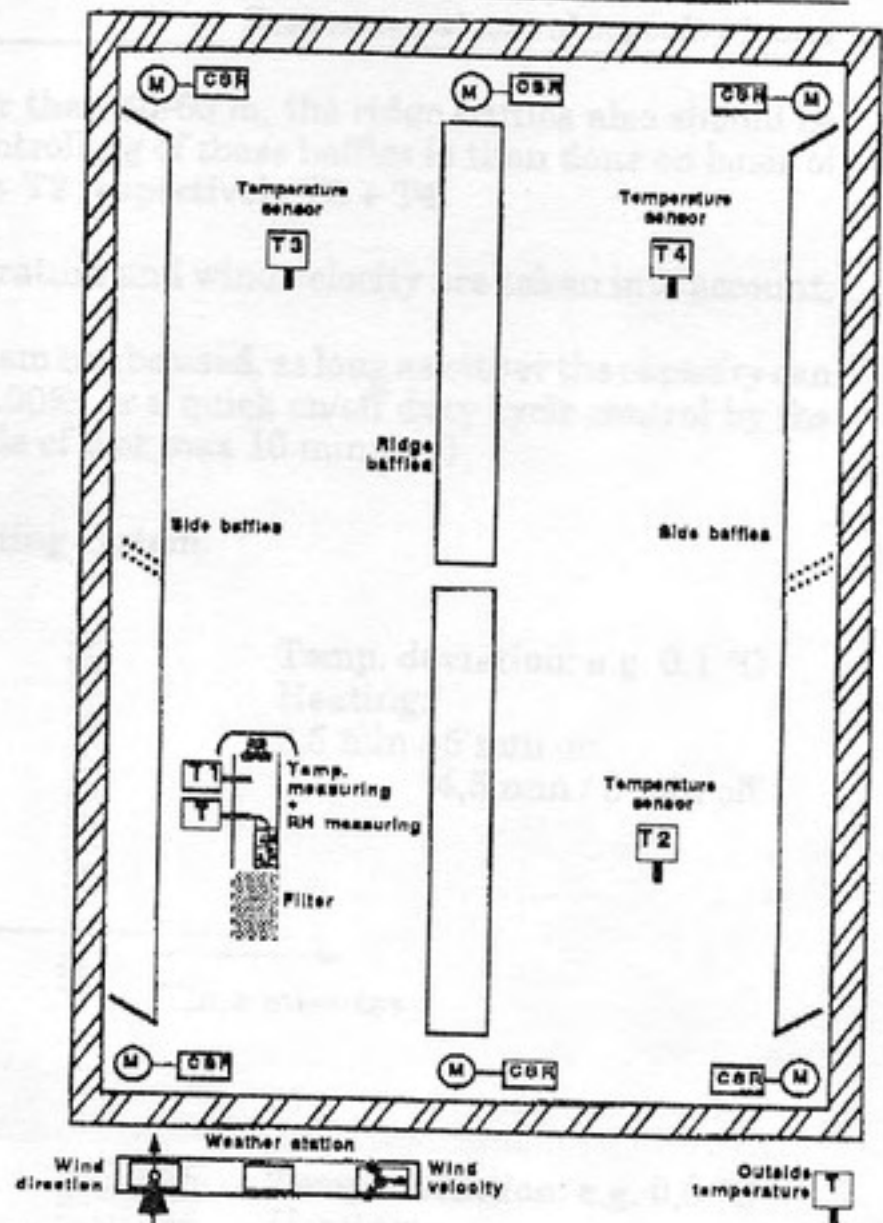


Fig 5: Natural ventilated house

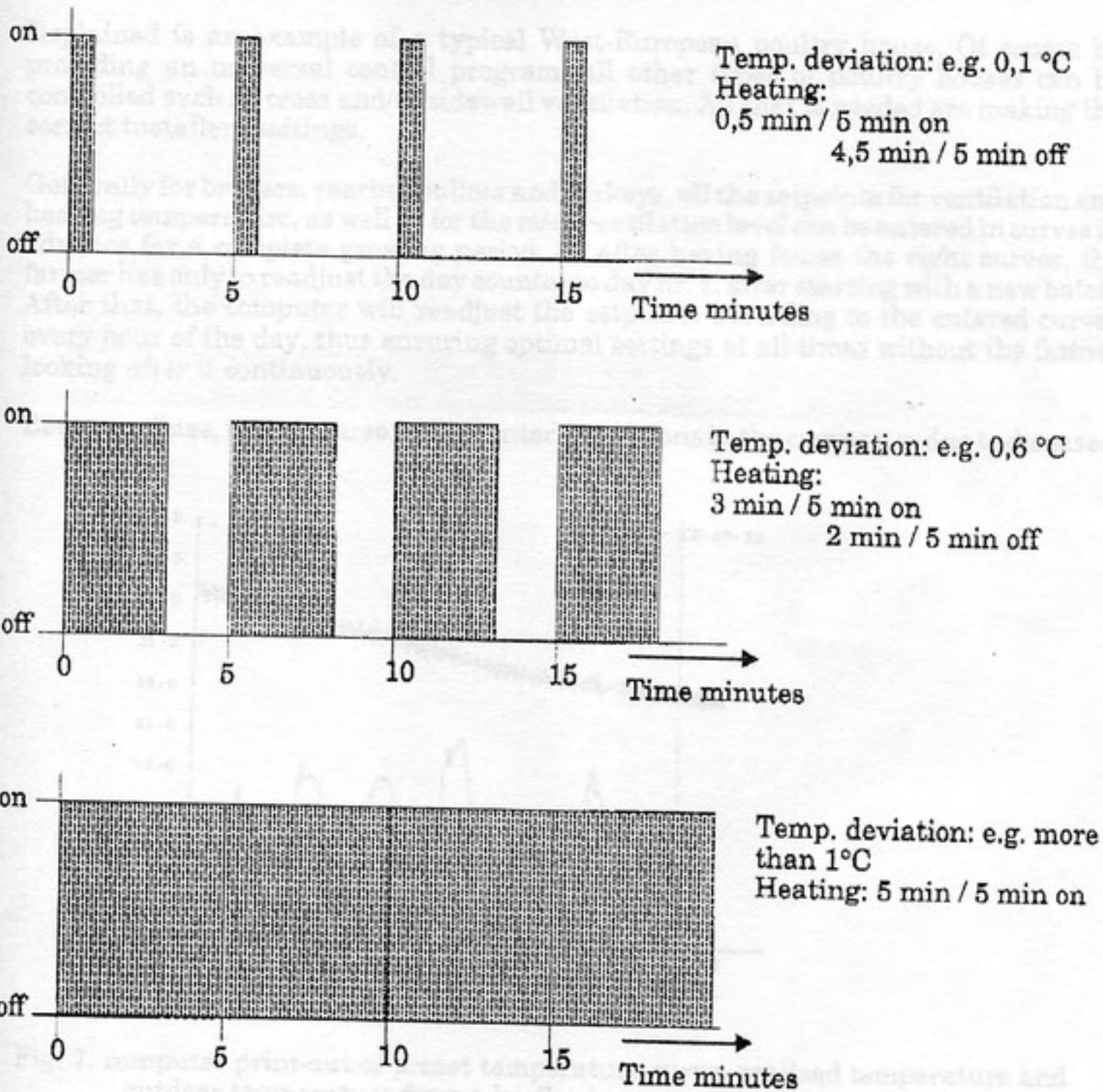


For natural ventilation houses longer than 40-60 m, the ridge baffles also should be divided into two separate groups. Controlling of these baffles is then done on basis of average temperatures of sensors T1 + T2 respectively T3 + T4.

For both systems, also outdoor temperature and wind velocity are taken into account.

For heating, every type of heating system can be used, as long as either the capacity can be controlled easily between e.g. 5 - 100%, or a quick on/off duty cycle control by the computer is acceptable. (e.g. duty cycle of 5 or max 10 minutes)

Fig. 6 Duty cycle control of on/off heating system.



NB Duty cycle time as well as max. temperature deviation for continuous operation can be set by the user of the system.

This system assures a very constant temperature without the, for on/off heating systems, well know temperature overshoot. As a result, a better climate and less waste of heating energy.

A too high relative humidity can, according to the user's settings, either increase the ventilation level, or increase the set point heating (or even both). Where the moisture content per m³ of air inside is higher than outside, this gives an increased moisture extraction, and thus a lowering relative humidity.

Explained is an example of a typical West-European poultry house. Of course by providing an universal control program, all other types of poultry houses can be controlled such as cross and/or sidewall ventilation. All that is needed are making the correct installers settings.

Generally for broilers, rearing pullets and turkeys, all the setpoints for ventilation and heating temperature, as well as for the min. ventilation level can be entered in curves in advance for a complete growing period. So after having found the right curves, the farmer has only to readjust the day counter to day nr. 1, after starting with a new batch. After that, the computer will readjust the setpoints according to the entered curves every hour of the day, thus ensuring optimal settings at all times without the farmer looking after it continuously.

Between times, it is of course easy to enter corrections in the curves e.g. due to diseases.

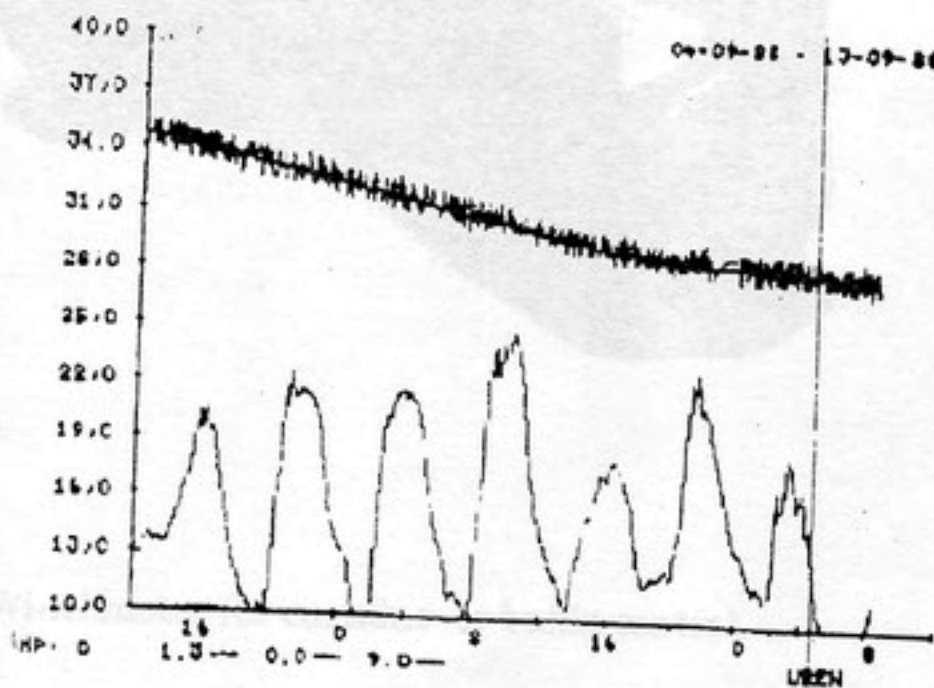
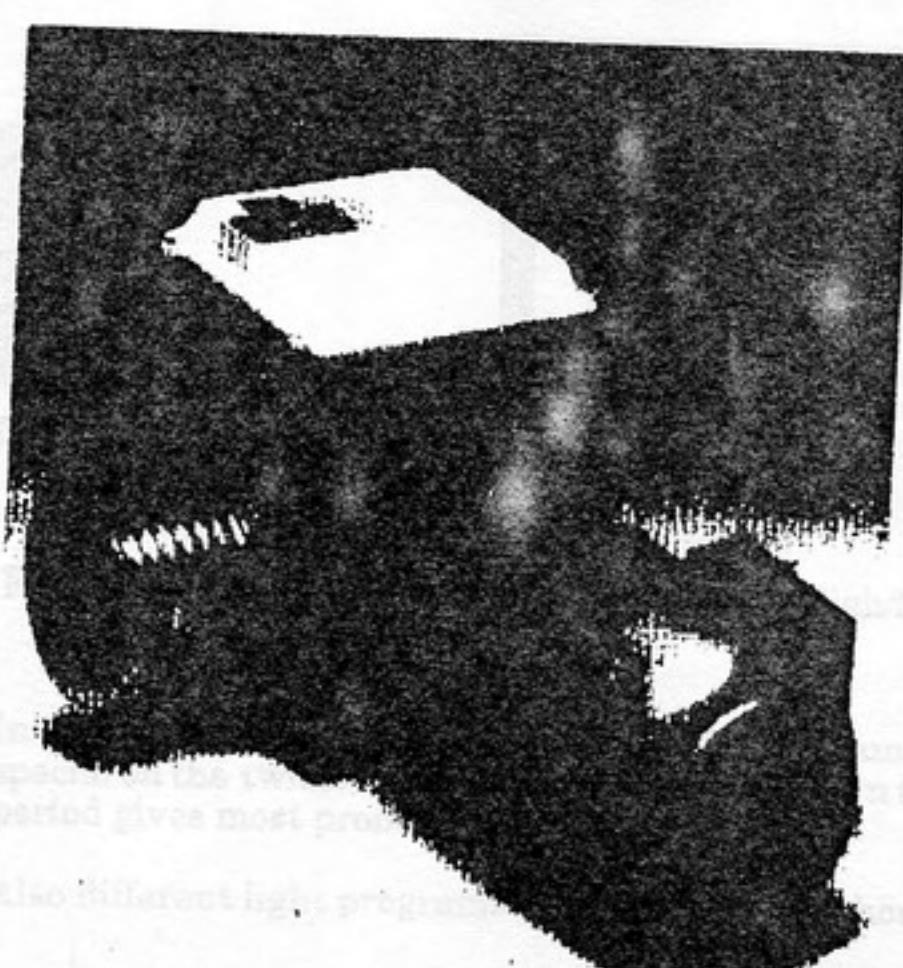


Fig. 7: computer print-out of preset temperature curve, realised temperature and outdoor temperature from a broiler house

Of course, the computer represents only the brains of the system, power units are needed to execute its commands efficiently. E.g. powerful actuator motors for positioning side- and/ or ridgebaffles.

used in most types of poultry houses. Various lighting schemes are used for controlling both the on/off times and the light intensity. Here, computerizing means an almost freely programmable lighting cycle per day, including light intensity control and a smooth change over from dark to light periods and vice versa.

So for windowless layer houses, e.g. the widely used biometric light program (15 min light - 45 min dark) can be set where e.g. also one or two light times (for feeding) during the night are possible.



Feeding time at midnight
under continuous light. Research
shows that a 1 hour light/8 hours dark
program is best for layer houses.

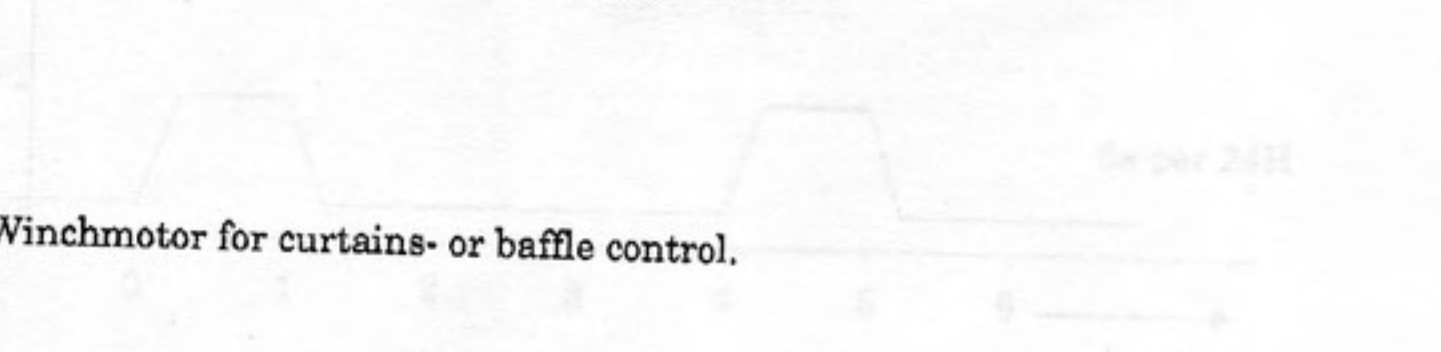


Fig 8: Winchmotor for curtains- or baffle control.

Fig. 10: light program for broilers

B. Light control

Artificial lighting is used in most types of poultry houses. Various lighting schemes are used for controlling both the on/off times and the light intensity. Here, computerizing means an almost freely programmable lighting cycle per day, including light intensity control and a smooth change-over from dark to light periods and visa versa.

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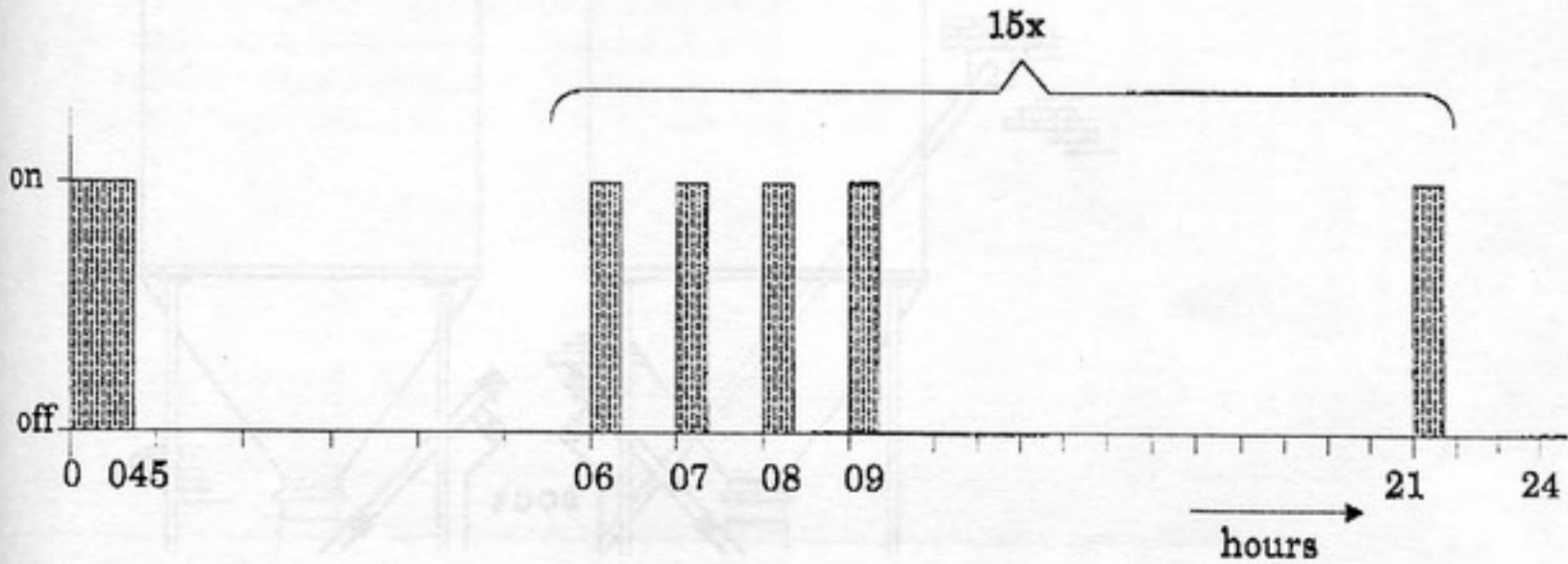


Fig. 9: Biomittend lighting system with extra light/feeding time at midnight.

In Europe, most of the broilers are still fattened under continuous light. Research special on the twisted legs abnormalities has shown that a 1 hour light/3 hours dark period gives most promising results.

Also different light programs are used in turkey houses.

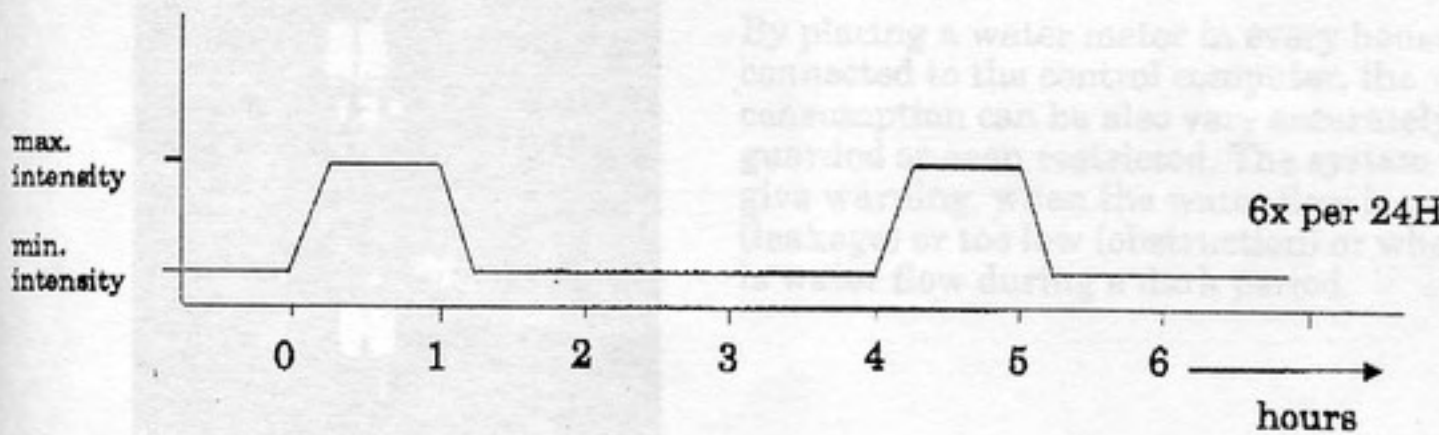


Fig. 10: light program for broilers

C. Feeding and water supply

In European circumstances, about 70% of the poultry production costs are feed costs. This is the main reason that attention should be paid to automatic feeding and accurate registration of feed consumption. In order to control the feed distribution and/or to obtain registration of the consumption, a feed weighing device with a high accuracy is necessary.

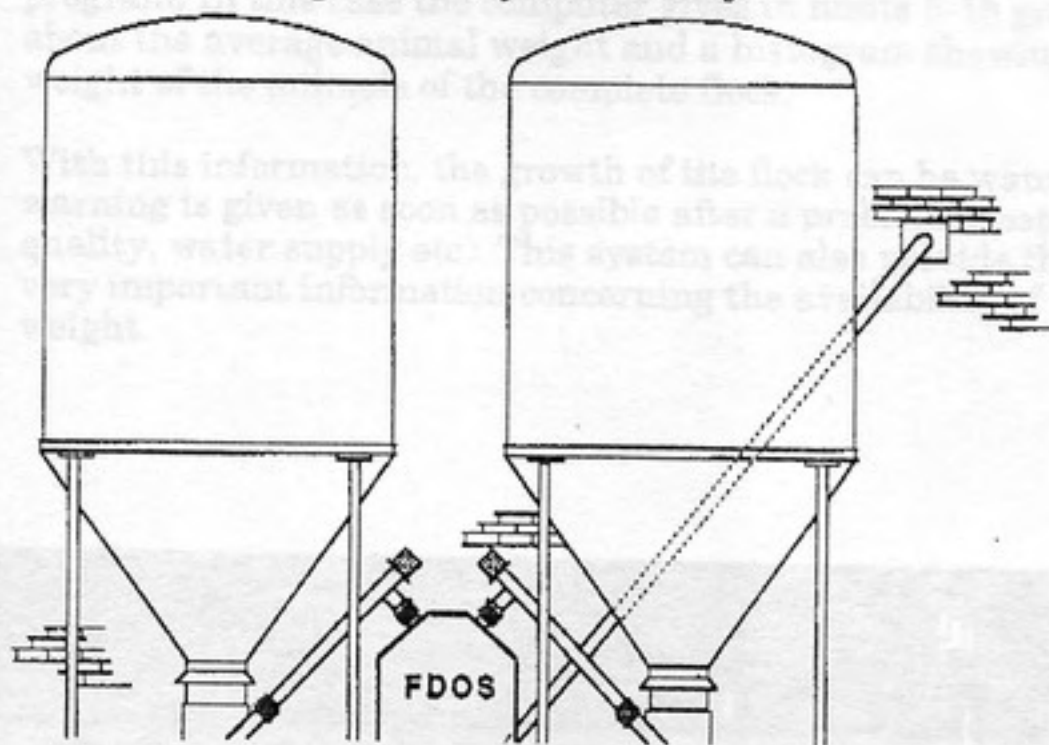
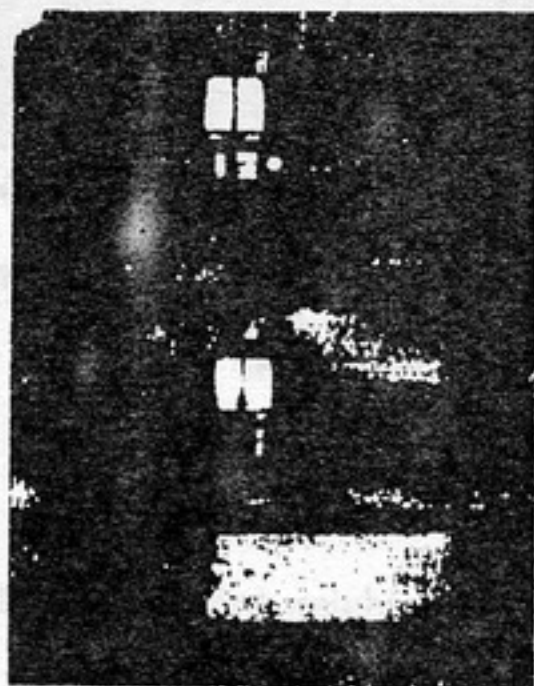


Fig. 11: FDOS continuous feedflow weigher used for 2 silos on one house.

Recently a new type of feed flow-weighing was introduced. This FDOS system provides high accuracy and is reasonably low priced. Two or three silo's per house can be used with one FDOS.



By placing a water meter in every house, to be connected to the control computer, the water consumption can be also very accurately guarded or even restricted. The system will give warning, when the water flow is too high (leakage) or too low (obstruction) or when there is water flow during a dark period.

Fig. 12: Electronic water meters for measuring water consumption in poultry houses.

D. Production

It is of course, very important to have production figures available not only at the end of a period, but at all times during the period, such as the increase of animal weight of broilers or of the daily egg-production, when possible per tier in laying cages. For this reason, a live-bird-weighting system was developed, with scales to be placed into the broiler house and to be connected to a computer weighing program. In this case the computer gives in limits 5-15 grams, the information about the average animal weight and a histogram showing the division of the weight of the animals of the complete flock.

With this information, the growth of the flock can be watched constantly and warning is given as soon as possible after a problem is established (disease, feed-quality, water supply etc). This system can also provide the processing plant with very important information concerning the availability of flocks with a certain weight.

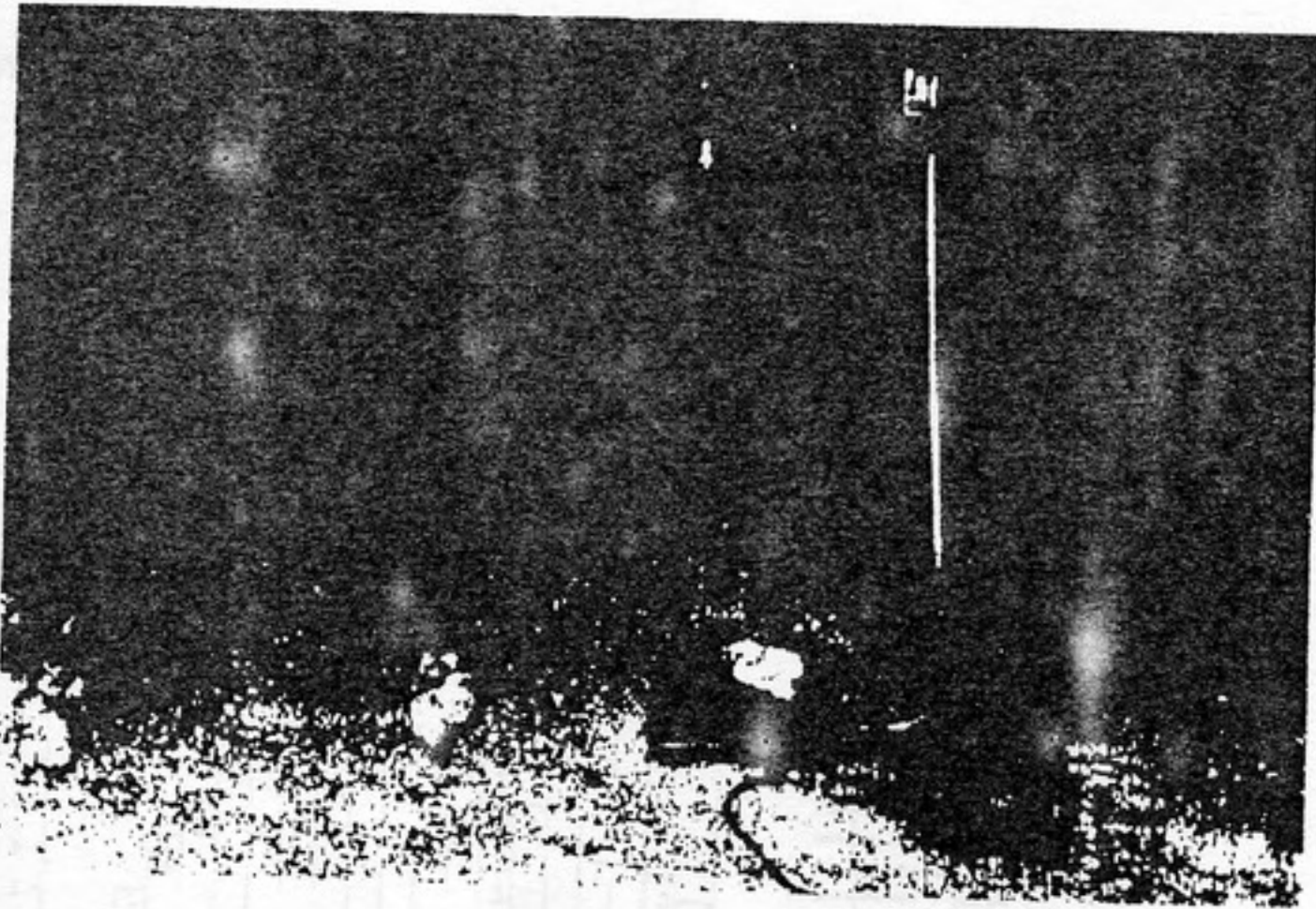


Fig. 13: live-bird-weighting platform.

For egg layer houses, a computer system has been developed to count egg production for each separate egg-collecting belt (2 per tier). This gives very detailed and continuous information about the egg production for each row separately.

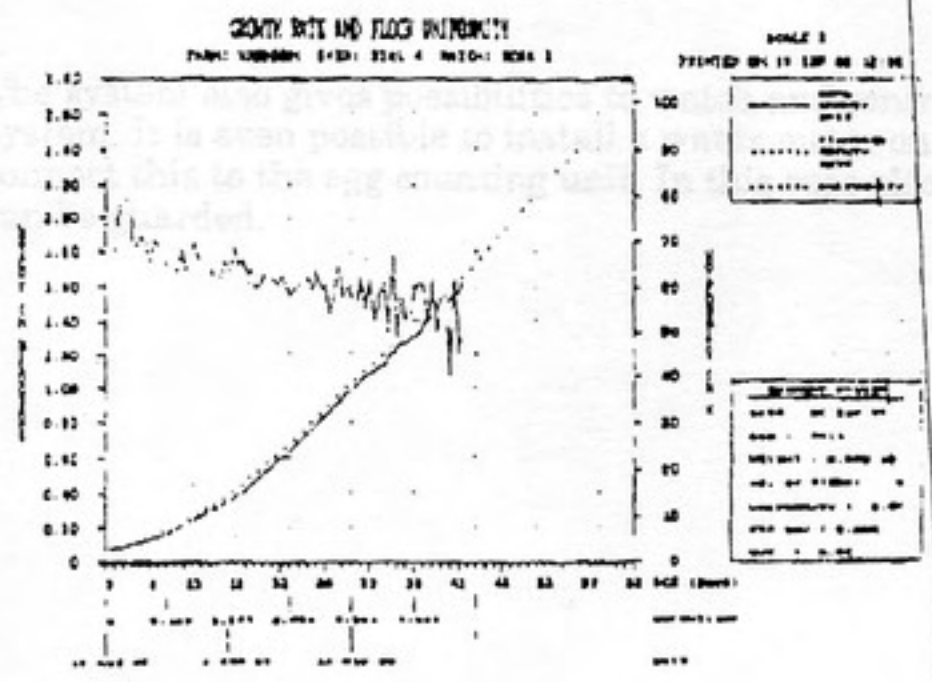


Fig 14: Standard and real growth curve of a broiler batch

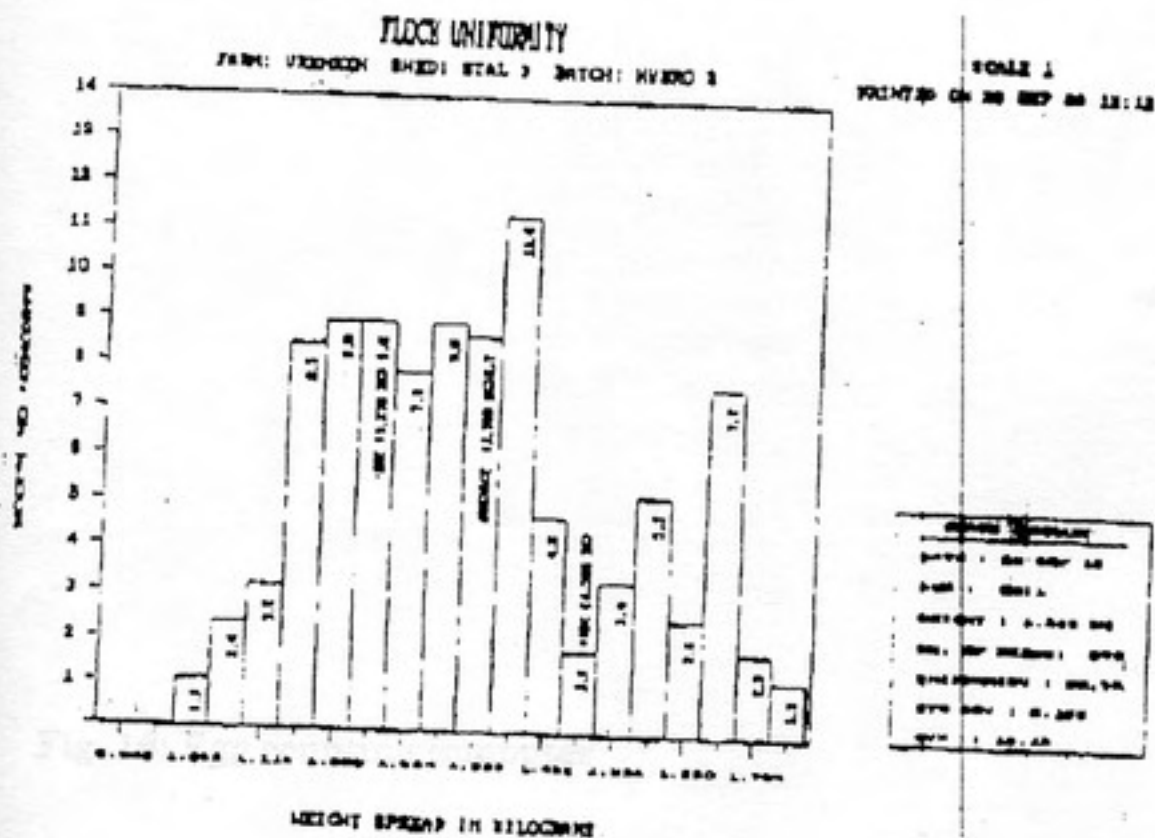


Fig 15: Weight distribution histogram of flock of broilers

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The system also gives possibilities to watch and control the complete egg-collecting system. It is even possible to install a water meter on each separate tier and to connect this to the egg counting unit. In this case also the water consumption per tier can be guarded.

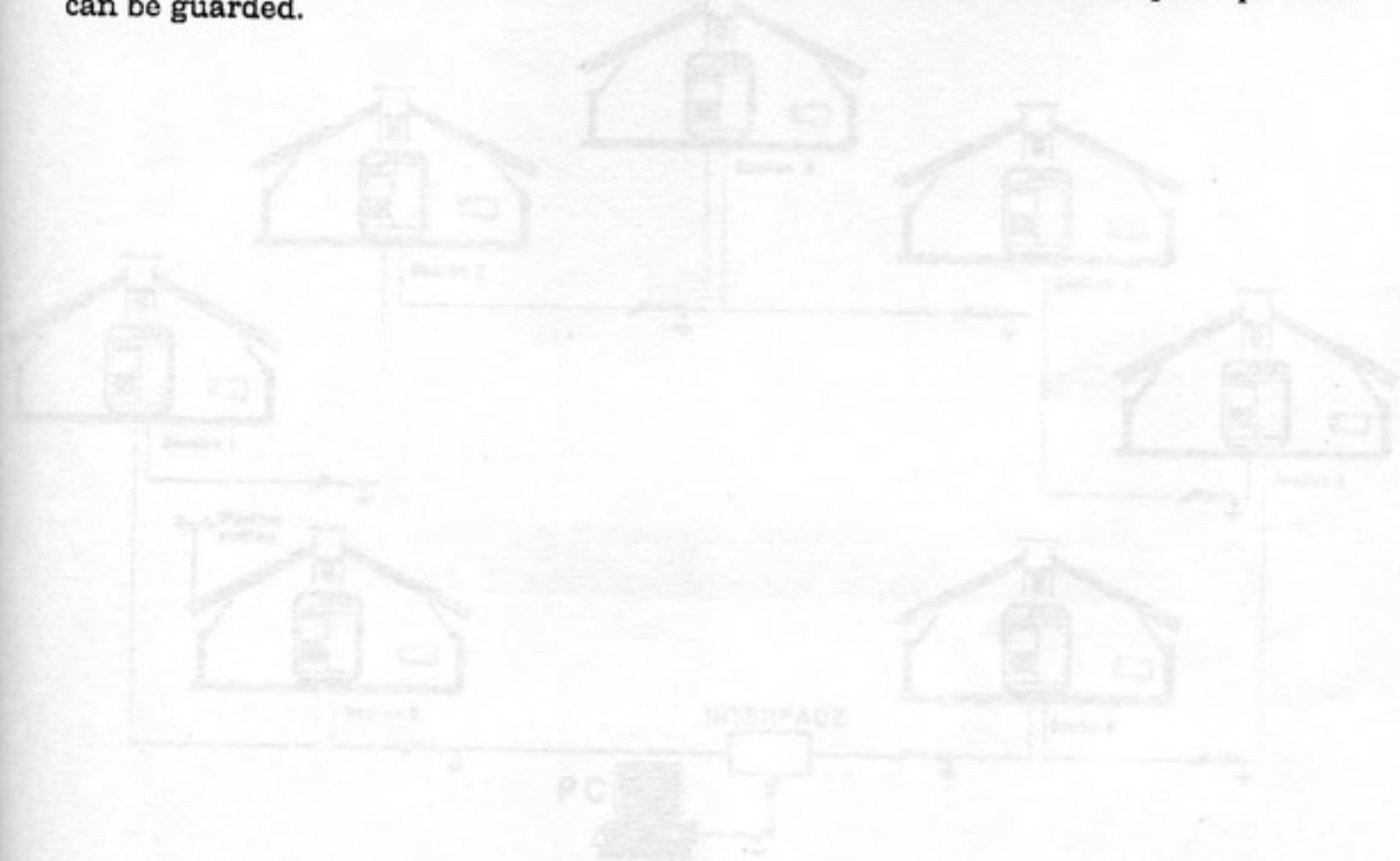


Fig 17: ESAPs in loop communication with a PC

One and more (max. 96) units can be hooked up to a Personal Computer. Via this PC, all data can be recalled and any changes can be made. Also the progress of the automation can be shown graphically.

More and more management programs for farm use are coming available, also for systems, which are able to exchange data with these programs.

Fig. 16: Egg counting computer

SYSTEMS SETUP

All the control-functions mentioned before, are incorporated e.g. in an ESAP decentral poultry computer. While it is a stand alone unit for one poultry house, all the necessary operations can be done by means of the keyboard and the alpha-numeric display. This unit also provides min/max temperature registration and many intelligent alarm functions.

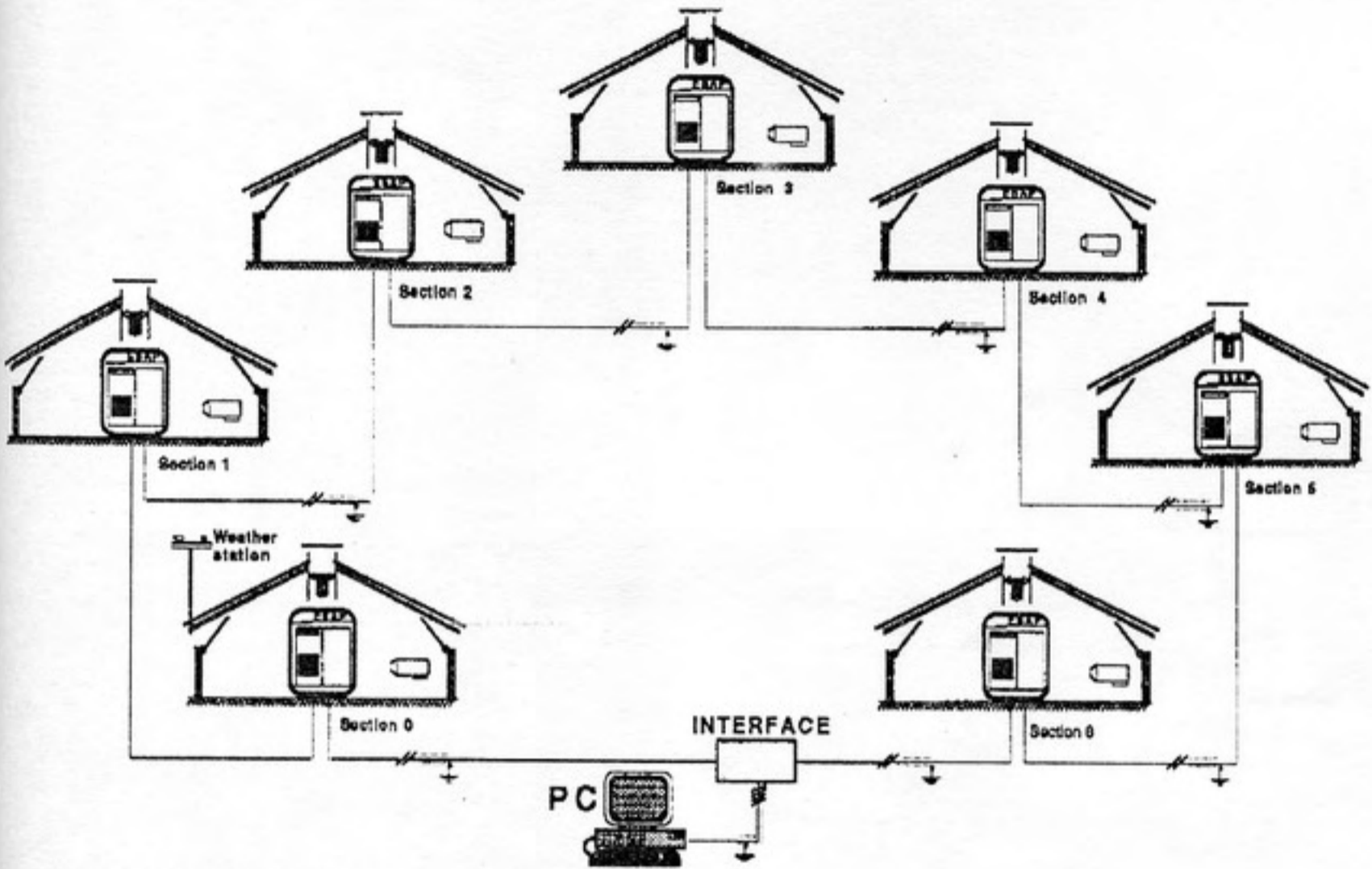


Fig 17: ESAPs in loop communication with a PC

One and more (max. 96) units can be hooked up to a Personal Computer. Via this PC, all data can be recalled and any changes can be made. Also the progress of the entire operation can be shown graphically.

More and more management programs for farm use are coming available, also for cycles, divisions etc. Of course to reach this aim that the poultry computers are able to exchange data with these programs.

FINALLY

A poultry computer can not grow broilers or ensure a good egg production by itself. The knowledge, experience and the trained-eye of a poultry man is necessary.

A poultry computer is just a highly sophisticated tool, helping the poultry service man 24 hours per day, to obtain better technical results and so finally higher benefits.