SUCCESSFUL INCUBATION

A WORKING MANUAL FOR LARGE HATCHING PLANTS

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LOS ANGELES CAL.

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PREFACE

This little book gives our experiences in hatching conducted for about six years. It is the story of our investigations, how we have finally stumbled on to the right way to hatch chicks. It is hoped it will save many the heart-rending experiences we have gone through. When you once know how, it is simple enough to hatch chicks, but it is not always easy to find out the simple way.

We also hope that there will be no disappointment to our readers. It seems that most poultry books are written by persons sitting by a cosy fire spinning theories that are utterly impracticable. This book is based on actual hatchery work and every effort has been made not to mislead any one or make claims unsupported by actual facts.

But there is still room for improvement and we shall be glad to hear from our readers if difficulties persist. All letters to me should be addressed to the publishers of the book, and they will be forwarded.

The price of the book may seem high to many persons, but it costs a great deal to publish a book. It is not the paper it is printed on, but the advertising that costs, and it is more than doubtful whether the publishers will ever be adequately paid for it even at its high price. It contains real information, that will be worth tenfold its price to any reader even the first year he uses an incubator.

Moreover, it must be remembered that all the inventions of this book are given free to the public, there are no patents on any of them. Everybody is at liberty to use what he likes. The proceeds from the book is the only remuneration the author receives.

P. COOK.

Los Angeles, Cal., Jan. 1, 1911.

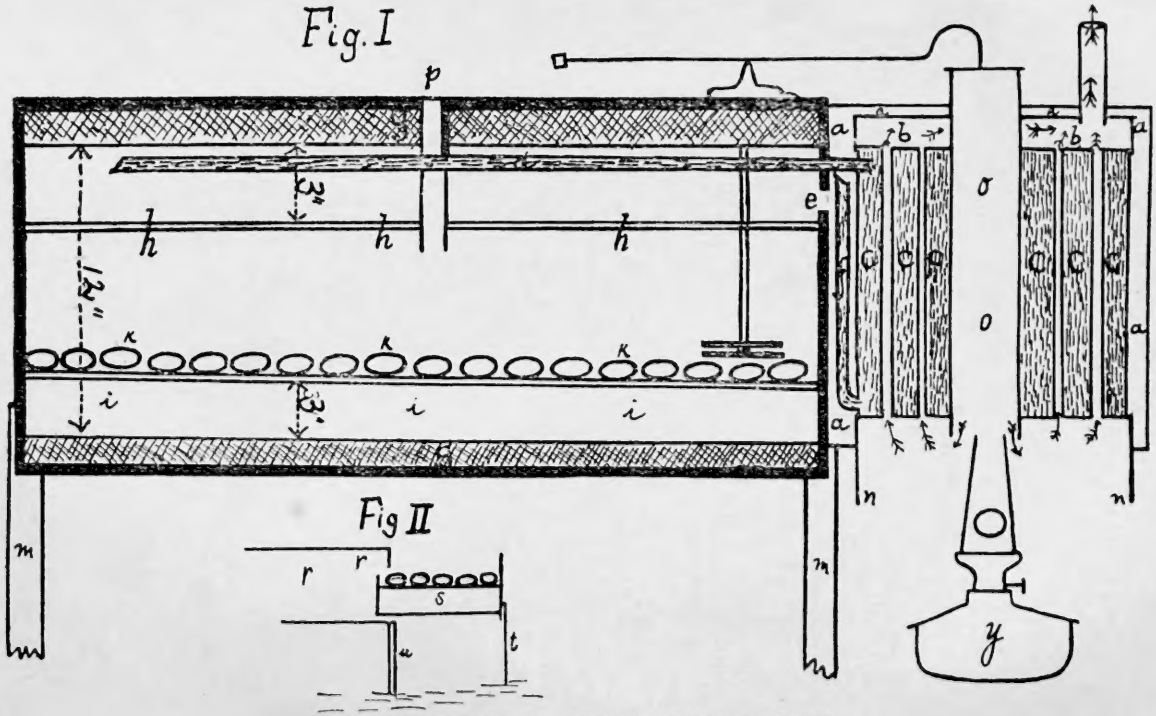


DIAGRAM OF P. COOK'S INCUBATOR

(For Description see Next Page)

DESCRIPTION OF P. COOK'S INCUBATOR

(See Diagram on Preceding Page)

Fig. 1. a, jacket enclosing boiler. This communicates with the outer air around its lower rim. The air thus heated by the sides of the boiler passes into the upper compartment of the incubator through the opening e, during incubation there is no other ventilation. It will be seen at once that this method procures a great deal of superheated air, which helps to take care of the evaporation from the eggs without unduly increasing the humidity of the egg-chamber. b, small tubes through which heat from the lamp, y, passes through the boiler, c, when the damper of the regulator is down. When damper is raised, the heat passes directly from the lamp through the large centre tube, o, without heating it, n, is a collar or rim compelling the heat from the lamp to ascend through small tubes, instead of dissipating below the boiler; f, portion of return pipe from incubator; d, portion of outflow pipe or coil entering incubator; h, thin muslin diaphragm separating upper and lower compartment of incubator, preventing any draft from air entering at e; k, egg tray; i, nursery; m, incubator legs; p, ventilating tube, used to dry off chicks after hatching. Kept closed during incubation.

Fig. II. r, incubator; s, drawer containing nursery and egg tray; t, stick on which drawer rests when pulled out.

Note.—All the experiments and successful hatches described in this book have been made with machines conforming strictly to this type. We have so far found this the most successful type, and used it equally well with hot air as with hot water heating.

INCUBATOR INSTRUMENTS

P. Cook's Carbonic Acid Gas Test, complete set of all necessary instruments, $5.00

P. Cook's Hygrometer, continuous reading, $3.00

P. Cook's Simplified Hygrometer $1.00 postpaid

(No one using an incubator should be without at least the Simplified Hygrometer. The other instruments are for large hatcheries.)

For sale by P. COOK, 3017 S. Main St., Los Angeles, Cal.

Note to page 21---No carbonic acid gas is given off by the body of the hen. We have made many tests to that effect. All that is found under her comes from the respiration of the embryo.

SUCCESSFUL INCUBATION

SOME EXPERIENCES WITH INCUBATORS.

Some of the strangest experiences take place with incubators. We have had our share of them. The very first incubator we bought happened to be a good one, and we had reasonably good hatches out of it, yet a considerable proportion of the chicks died in the shells. We supposed that with more experience we would be able to get better hatches, but the contrary proved to be the case. After two hatches we moved this incubator to another building, and we had nothing but poor hatches from it in spite of the best of our care, so we gave up that kind of an incubator. Then we heard of one that was producing very good hatches through an acquaintance, and we invested in that make, but it would not hatch for us in any way at all. We tried it six or seven times, and lost practically every hatch. Then it was moved to another room, and as we were badly needing an incubator to take care of some surplus eggs, we decided to run it once more, and the machine has given very good hatches to the present date, standing in this one place.

In the meantime we also built different types of incubators of our own to find out, if possible, the difficulties in incubation, and though we constructed over thirty different types of machines, and tried almost every conceivable method we did not seem to make any particular headway. It was always the same old story, sometimes a very good hatch, and then a number of very bad ones. We tried it three times with one very popular make of incubator, and in each hatch as many chicks were dead in their shells as those that succeeded in getting out. We sold the machine in disgust. The man who bought it from us moved it to his house, and the machine hatched every fertile egg, although he had never run an incubator before.

We had another machine which we built ourselves that gave a very remarkable hatch, and we hoped we were nearing the goal. We moved it to another room in our hatchery, and it would not hatch there at all. And more perplexing still was another case of a machine holding about 1000 eggs. It had four drawers, and the two drawers in the rear end of the machine always hatched very well. The two drawers in the other end of the machine, while the temperature was the same throughout, never hatched at all, i. e., most of the chicks died in the shell, or were cripples, though it was impossible to discover any difference in the machine.

Another peculiar case we had was this: Someone brought us some eggs on which a hen had set for four

days, and then died on the nest. It was about 18 hours after the hen was dead that the eggs were brought to us, and the eggs were stone cold when they arrived. We placed them in an incubator with 300 eggs in it, which had been set just about the same time. At the time of hatching we secured nine strong, lively chicks from the eggs the hen had set on, and there was only one egg which was fertile that failed to hatch of the hen's clutch, but the 300 in the incubator practically did not hatch at all, i. e., there were about fifty miserable chicks that got out. The rest did not get out of the shell at all.

We have tried a great variety of different makes of machines, and we have had the same story with all of them. Sometimes they hatch very well, and sometimes they do not hatch at all. Most of the time there are more dead chicks in the shell than there ought to be with all of them. Some machines are far better built than others, but even the poorest made machines have given us just as good hatches, as the most expensive ones.

The glowing testimonials which all the incubator manufacturers send out are probably genuine, as we could duplicate most of them once in a while. Nearly every make of machine we have seen sometimes give as good hatches as claimed, but there is always against the one success a woeful lot of failures. Of course, if eggs are exceptionally strong and vigorous in fertility, they will perhaps hatch under almost any conditions, but the great necessity for poultry raising is to get an incubator that will hatch nearly as well as the hen, and in all our experiences with the hens we have found that, barring accident, she succeeds in hatching practically all the fertile eggs. We soon became convinced, of course, that something must be wrong with the incubator, but the harder we tried to find out the farther we seemed to be from the goal.

It is easy to build a new incubator, and build one that one thinks is a great improvement. Ninety-nine times out of one hundred it will be found, however, that the new machine is worse than the old one. It is needless to rehearse the whole history of our experiences. I simply mention these things to show that in the way incubators have been constructed hitherto some vital things have been lacking, and if anyone has experiences similar to these, he must remember that every other poultry man is apt to find such happenings some time or other. It is true, some poultrymen have been singularly fortunate in having almost always good hatches, and others have been singularly unfortunate, in almost always having very poor hatches. However, we think that, in the following pages we describe a method which will enable anyone to secure hatches nearly as good as those the hen produces.

So far as we know we have good reason to believe that the essential principles of incubation have been discovered, and the only thing that remains to be done is to

reach a greater perfection of our method. At any rate, the only way to discover the right method is by unceasing experiments, and we shall be very glad if persons who follow our method will report to us the success, or lack of success, which they have. We hope for the heartiest co-operation in this respect, as the first principle in successful poultry keeping, is the successful hatching of strong, vigorous chicks.

It is certain that in an incubator where fifty per cent of the chicks die in the shell, the chicks that actually do get out have not been incubated under desirable conditions, and must have suffered considerable, which means that they are handicapped from the first.

It is an unfortunate thing that it is almost next to impossible to have people willing to acknowledge their failures in hatching. Every body seems to think it a disgrace to acknowledge the unsuccessful hatching of his eggs. It is time that there be a little more honesty among poultry men in this respect, and if anyone has discovered a successful way of hatching he should be willing to let his neighbors know it.

We believe that we have made very important discoveries and therefore publish this little volume, but we desire to have it taken as an incentive to more careful experiments, much rather than as an entire solution of the problem.

The most careful methods are necessary for this investigation, and much patience must be exercised, but the fact that every once in a while an incubator produces perfect hatches shows beyond a doubt that the goal of unfailing success is attainable, and if we are patient enough and work hard enough we shall finally wrest from nature her secrets.

HOT WATER OR HOT AIR INCUBATORS.

We have used very extensively in our tests, both hot water and hot air incubators, and so far as the hatching of eggs is concerned, it makes not the slightest difference which is used, providing it is constructed properly.

Manufacturers of hot water machines should see to it that their hot water tanks are well made, and especially should avoid any combination of galvanized iron with brass or copper, as these are sure to leak in a very short time, on account of electrolysis.

We should advise, however, for all small machines, the use of hot air, as we have found in our experience that it gives much less trouble. If once such incubators are built right, they last practically a life time. The heat is not as even in a hot air machine, as it can be made in a hot water machine. But a little unevenness of heat seems to be of no importance. The hot-air machine is less trouble to take care of than the hot water machine. However, the hot air machines can hardly be built successfully to take care of more than 500 eggs. If larger machines are to be used, hot water is required.

We have also experimented with a great many different boiler systems, but find a copper boiler with a large tube through the center, and a series of small tubes running parallel with it between the large center tube and the sides of the boiler, to be the most successful. The damper is placed over the large center tube connected with a thermostat. When the damper rises, the heat from the lamp or gas flame passes directly through the center tube without heating any water in the boiler. When the damper is closed the heat passes up the center tube and returns through the smaller tubes before finding an outlet, thus giving an immense heat surface.

The requirements for incubator boilers are that they should have an immense heating surface when the damper is closed, and when the damper is open none, or at least only a very small amount of heat should pass to the boiler.

The best circulating system we have found to be wrought iron pipe connected in the ordinary way to the boiler, but the outflow pipes should be connected to the top of the boiler, and the return flow should enter the bottom of the boiler. The boiler always must be placed somewhat lower than the outflow pipes. In our practice we place the outflow pipes at the top of the boiler, and let them rise gradually about one inch, or sometimes two inches to the extreme back of the machine, and then let the return pipe have a fall of about two inches through the length of the incubator, and then let it pass down to the bottom of he boiler. It does not make any difference how far the highest point of the pipe is from the boiler, as hot water will rise to the top, but there must be an even fall from the highest point to the return, in order to insure good circulation.

In hot air machines the difficulty is to spread out the heat toward the sides. There are several ways which seem to do the work equally well, and a number of different systems are in use on the incubators on the market. We cannot see that one has any advantage over the other.

HINTS TO THE MANUFACTURERS OF INCUBATORS.

Incubator Case, Doors, Etc.

There are very few incubators on the market at the present day that are built sufficiently well for the purpose for which they are intended. Many incubators are built so cheaply, and in so slovenly a manner that no man who cares to hatch eggs should ever be tempted to buy them, no matter at what price they are offered. They are too expensive even if they were given away. The first requirement for success in raising poultry is to hatch strong and vigorous chicks, and unless an incubator is well built, you cannot possibly do this. It is not the material that is used in the incubator which is of so much consequence, but the workmanship in putting it together is of the very greatest importance. Every incubator

should be built of double walls throughout, and at least on top, should have a thoroughly heavy packing of heat insulating material. But more important than the packing is the care with which joints are made. They should be made on proper machinery and carefully glued together, so as to make the incubator case air-tight, especially the door should be made to fit absolutely air tight. This is almost impossible to accomplish unless the edges of the door and its casings are lined with felt. There should be double doors, one glass door next to the eggs, and outside of that a solid wood door. This is preferable, for if chicks are kept in the dark while hatching they will remain evenly scattered over the incubator. If there is only one glass door chicks will all crowd to the front. This may be obviated somewhat by placing the glass high up in the door, and leaving a considerable dark space at the bottom, which keeps the light out of the nursery. But far better than the arrangement of glass doors, and egg trays is the method of construction used in our Mammoth machines. These have simply a large drawer, which fits tightly in the machine. The egg trays are placed within this drawer, near its top, and for airing the eggs, the whole drawer is pulled out of the machine resting one end upon the incubator, and the other on a stick fastened to the front of the drawer. A small window screened with curtains is cut in the upper part of the drawer through which the temperature may be read, and chicks may be watched at the time of hatching. This arrangement saves a very large amount of labor, as the chicks can easily be gotten out, and the eggs are always protected from drafts, as the sides and bottom of the drawer are solid, and thus prevent any drafts from striking the eggs.

THERMOSTAT, LAMPS, ETC.

It is immaterial what kind of thermostat is used, whether it be composed of different metals, or ether wafers. Everything here, as everywhere else, depends upon the care with which they are made. Either kind will last a life time, if well made, but it is quite important that all the bearings should have knife edges and should be patterned after the method of bearings used in weighing-scales.

When possible only one direct lever should be used, and the method of regulating the heat should be that which is commonly known as the damper method. Any thermostat working on the wick of the lamp is always more or less unreliable, as the wick sleeves are sure to char some time or other, and thus prevent its working. While there is a little saving of oil on the lamp trips, they are sure to spoil the hatch sooner or later, and thus may be expensive in the end.

Lamp bowls should be made either of galvanized iron or copper or brass, and they should be well and strongly

made, and the upper part of the lamp bowl should be perfectly smooth, sloping toward the edges, so that no oil will stand on it.

If the boiler of the incubator is constructed properly, arrangements to keep water on the lamp, or around the flame are unnecessary, and had better not be used. The final outlet of the bad air from the lamp should be at least twelve vertical inches above the flame, no matter how far endways, or sideways this outlet is found. Otherwise there will be heating of the lamp flame, and of the lamp bowl, and there is danger of generating explosive gases.

Lamp chimneys should be made of iron with a large mica window at least 2 inches in diameter, but see that your chimneys are faultlessly made, for drafts from the chimneys will cause the lamp-flame to smoke, and become dangerous. The lamp on any incubator should be carefully locked. No spring arrangement is ever to be allowed, for springs, no matter how good they are, will get weak in a short time, and the lamp will not fit properly. The lamp should be so securely locked to the incubator that it cannot be knocked off; even if the incubator should be overturned the lamp should still stick to it. To encase the incubator in metal is useless, the danger comes from the lamp, not from the incubator. Common sense requires these precautions.

Thermostats should have a protective covering so that cats and dogs, or children or plaster that may fall from the wall on them, would not throw them out of position. It is to be remembered that any thermostat must of necessity be a delicate instrument, and it should be made accordingly, and treated accordingly.

CARE OF BREEDING STOCK AND FERTILITY OF EGGS.

We have used eggs from birds kept under all sorts of conditions. Birds that have run on the wide range, and birds that for several years have been confined in very small pens, also eggs from birds fed on pure grain and birds that were fed on nothing but garbage. We have not been able to detect any difference in the fertility, and vigor of the embryo in the eggs, as far as external conditions and feeding of stock is concerned. More seems to depend upon the vigor of the fowls, and especially the males. Males should have a rest some time during the year, or should be interchanged with others. This much, however, is certain, that birds kept on a very large range have the best chance of producing vigorous strong germs in the eggs intended for hatching, but it must remain for further experiment whether confining birds or different methods of feeding affect the vigor of the embryo in the eggs.

CARE OF THE EGGS.

One of the first requirements for successful incubation is the proper handling of the eggs. Eggs should be gathered as soon as they are laid, and not exposed to the heat or bright sun. They should be carefully placed in the ordinary market egg cases, and should be kept in a cool place (55 degrees), but under no circumstances should they be exposed to draft of any kind. The fresher the eggs are, the better they will hatch.

If it is expected to hatch every egg that is placed in the incubator, no eggs over three days old should be used. However, we have sometimes had reasonably good results from eggs that were three and four weeks old. There is a popular idea that eggs intended for hatching should be turned every day. We doubt very much if this does them any good. It is of much more importance to handle the eggs very gently, for the jarring and shaking of them is a heavy strain on the various membranes of the egg. Violent shaking of the egg will destroy all its possibility for hatching, and the less eggs intended for hatching are handled, the better it is.

If eggs have become soiled, they should be washed, but it would be better not to use any eggs that have been washed, or subjected to any unnatural conditions in any way. A clean egg gathered from the hen's nest and placed immediately in the incubator has tremendous chances over an egg that has been more or less abused.

Defective eggs, and those with round ridges through the middle, or rough shells, or imperfectly formed shells had better be discarded, as well as very small or very large eggs. They will hatch very well at times, but the chances are somewhat against them of producing a perfect chick. Remember, do not expose your eggs to the sun. Keep them cool, (about fifty or fifty-five degrees), but do not chill them, and above all handle them very gently, and keep them out of the draft.

THE PROCESS OF INCUBATION

THE RIGHT TEMPERATURE FOR INCUBATION

We have made a large number of tests of the temperature of eggs under the sitting hen. It is rather difficult to arrive at any exact temperature. The eggs on the outer edges of the nest are usually considerably colder than those in its centre, but as she shifts them around a great deal, all the eggs receive the highest temperature which she produces sometime or other during the day.

If the thermometer be placed among the eggs, we have not generally found it to register over 100 to 102 degrees. If the thermometer be applied to the hen's body, we have quite often found a temperature of 104 to 107 degrees. Great care must be exercised in taking the hen's temperature, for as soon as she gets the least worried, her temperature rises rapidly, and often in a few minutes registers 108 degrees or more. Even a non-broody hen, with normal temperature of 98 will soon rise to 102 if agitated.

The safest method of arriving at the temperature of incubation under the hen is to thrust a sensitive thermometer quickly into the middle of the egg taken from the center of her nest. Numerous tests which we have made in that way, always range closely between 102 and 104 degrees. Upon the whole, perhaps no better incubating temperature can be found than 103 deegres.

In our practice the thermometer bulb is placed level with the top of the eggs, and either left in contact with the eggs, or very close to it, and the eggs are incubated throughout the hatch from the beginning to the end at 103 degrees. Under this temperature if the eggs are fresh, chicks are almost always all hatched at the end of the twentieth day. Sometimes, if weak, or old, they will not hatch till the 21st day or later.

It is very important that the temperature be 103 degrees at the very beginning and should not drop below it during the first six days. After being placed in the machine eggs should reach 103 in three to five hours If it takes longer to reach the proper temperature, eggs are sure to suffer. Nothing is so bad for eggs as say 80 to 85 degrees of heat for the first day. Some successful hatchers even start at 106 and gradually drop down to 103. Watch your machine the first week as the apple of your eye. After that you may sleep in peace.

Beginners are often needlessly worried if the temperature accidentally for a short time drops too low. Eggs will successfully withstand quite a considerable amount of low temperature, if it comes only once, but they will

not stand endless see-saws of it. We have successfully hatched eggs that accidentally were left out of the machine as long as from ten to twenty-four hours, and reached a temperature as low as fifty degrees, during part of the time. No bad effect seemed noticeable. The chicks were perfect. But if there is a see-saw of temperature, say even between 95 and 105 degrees, for several days, the hatch is usually spoiled.

Overheating spoils the eggs much quicker than low temperature. It depends a good deal on the age of the embryo, how fatal overheating will prove. Up till the 6th day a temperature of 110 for several hours will probably kill all the germs, though we have had them withstand this for fifteen minutes or so, but where they were exposed to this temperature for a longer period, we always found all embryos dead.

We have one case on record, however, where the incubator, by accident, had reached 115 degrees (end of 7th day of incubation), and stood at this probably for a full hour or more. We only lost about 10% of embryos. These all died within the next day. All the rest of the embryos hatched perfectly, there were neither cripples nor weaklings of any sort.

CRIPPLES.

Neither overheating nor chilling the eggs will cause cripples. We have never found any other cause of cripples than drafts in the machine or too cold a bottom in the nursery. We had one case where the incubator hatched reasonably well, but 65% were cripples. It was found the bottom of the nursery registered only 75 degrees. For the next hatch the nursery was filled with straw and cotton batting, and no cripples appeared. Perhaps the under side of the egg being so much colder, retards the growth of the embroyo on that side, or chills it, and thus deranges the normal development of the chick.

It has been claimed that lack of turning causes cripples, but we have not found it so. In one of our tests, one half of the incubator was not turned at all during the entire period of incubation and the other half was turned three times a day. The half of the incubator which was turned hatched normally. The half that was not turned at all, hatched but very few chicks, but there were hardly any cripples. Most of the chicks grew to maturity, but did not get out. Many died during the second week, but not a single germ was stuck to the shell. In the half that was turned, there was one germ stuck to the shell. Evidently turning or not turning has nothing to do with germs sticking to the shell. Such germs are defective. They have risen to the top and in some way become attached to the shell, but probably not till after they were dead. Their death is probably the cause of adhering to the shell. At any rate, such could not have been saved by turning. Ill-fitting doors will almost certainly cause cripples in cold weather.

TURNING THE EGGS.

Our present practice is turning the eggs twice daily, twelve hours apart, as nearly as possible. We have had very successful hatches, however, where the eggs were turned only once a day, and we have even had really good hatches where the eggs were turned only five times during the entire period of incubation, but upon the whole our experience tends to show that turning twice daily brings decidedly the best results, providing a mechanical turner is used. If the eggs cannot be turned in the machine without opening it, they should not be turned at all for the first three days, and thereafter only once a day, for only strong eggs will stand opening the machine twice a day, all the weaker ones will die in the shell or hatch with protruding entrails, unabsorbed yolk, etc.

THE MECHANICAL TURNER.

The mechanical turner was used years ago, but proved a failure. For that reason it was one of the last things we tried. But one day after a miserable hatch, such as might even make a strong man almost come to tears, we sat down dejectedly in the woodshed by the old hen, trying to make up our mind whether to abandon the whole wretched hatching business or to try it blindly once more, we noticed that she shifted her eggs around every 20 minutes or half hour, but she did not get off the nest to do it. She seemed to hug her eggs all the closer while she turned them. This was a lesson, we had not watched nature close enough in this respect. We built a turning rack, so that we could turn eggs as did the hen, without exposing them to the outer air, and in our very next hatch we suddenly found ourselves much nearer the goal. The easiest way to make such a mechanical turner is to use thin strips of wood ¼-inch thick and about ¾-inches wide. Make a rack of these to fit closely into your incubator tray after the manner of a ladder with the rungs about 1¾ inches apart. The side of your rack parallel with the rungs should be two inches shorter than the tray, so that this rack can slide forward and backward upon the tray. The eggs are placed between the rungs and when the rack is moved forward or backward all the eggs are turned. The rungs of course are nailed so that when the rack is placed upon the tray, the side or the rungs is at right angles with the bottom of the tray. A thin strip of wood nailed on the top of the wire-bottom of tray on its sides makes a nice rail for the rack to slide upon. Small holes can easily be bored through the door of the incubator through which one or two small wire hooks can be inserted to pull or push the turning rack forward or backward without opening the door of the incubator. A plug must be inserted in the holes after turning. This turning-rack takes up some space and not as many eggs will go into the machine, as without it, but you will get more chicks out of the machine by using it .

It seems that so simple a thing as this ought to have been found out long ago, but apparently it was not. It took us six weary years to discover this as well as other things. The success and failure of a hatch sometimes depends on very little things. There are a thousand wrong ways to hatch eggs, we know a good many of them. There is only one right way, we hope we have discovered that in part at least. Remember, turn your eggs twice a day, but never open your machine more than once a day. Never!

TESTING EGGS.

In our practice the incubator is opened for the first time on the 84th hour. The eggs are taken out and tested. The tray is set on a table with a blanket placed under the tray to protect the eggs from cold air circling around underneath them. They are left exposed on top We are using a 16 candle power electric light bulb enclosed in a tin globe (can be made out of a baking powder can), which has two round openings one inch in diameter. The eggs are held up two at a time, one against each opening, when their contents may be clearly seen. A darkened room must be used. When no electric light is available, the best method is to make a tube about fourteen inches long of black paper, roll it into funnel-shape with the smaller opening about 1½ inches in diameter and the larger about six inches. Take an egg, place it against the small end, hold up to sunlight, and look through the large opening, the embryo may then be clearly seen. Practice will soon teach to distinguish between the fertile and infertile egg.

Whatever method is used, care must be taken in handling the eggs very gently, and they should never be exposed to strong light except for the briefest possible moment, nor should they be suddenly taken from a dark incubator into the glaring sunlight.

It should be remembered that the hen generally hides her nest, and eggs are never exposed to strong light. While it is not known what damage might result from exposure to strong light, it is not likely that nature has made any provisions against it. Whatever is done with eggs, be careful not to transgress upon nature's methods

COOLING THE EGGS.

We have not come to any conclusion as to the length of time eggs should be cooled. The investigation of desirable hatching conditions has been so exceedingly tedious, and in order to arrive at certain results only one thing can be taken up at a time. It is undoubtedly best to follow the natural method as closely as possible, as the hen does not leave the eggs more than once a day for over five to fifteen minutes, and the cooling of the eggs for a similar length of time probably comes as near being right as possible. Under no conditions should the eggs be cooled more than once a day, or be removed from the machine more than once in 24 hours.

INFERTILE EGGS.

About the fourth day the embryo will appear in spider-like form in the fertile egg, the red blood veins issuing from the centre in all directions. This is the natural appearance of a vigorous germ. Where the veins have run together into a bloody streak, the germ is dead. Experience alone will teach to distinguish between living and dead germs during later periods of incubation. An infertile egg shows perfectly clear before the tester, except that in white-shelled eggs the yoke may be clearly seen.

The object of testing eggs is to secure the infertile eggs. If eggs were not much more than three days old when put in the machine, these infertiles that are perfectly clear are practically as good as any other egg not over seven days old. However, they should not be sold for fresh eggs, but they are excellent for baking, cooking, etc., and are decidedly superior to storage eggs. In testing the eggs for fertility, they should be taken from the incubator without turning, the germs will then all be found lying on the upper side of the egg. They should be held up to the light and if turned at all, it should be done gently.

After all the infertiles have been removed, these latter should be re-tested to get the perfectly good eggs. Hold the egg up to the tester, then give it a quick jerking turn, if the egg looks watery then, it is no longer good. It needs experience to distinguish good from bad eggs. Break open enough till you find out.

HOW TO TELL INFERTILE EGGS.

There is absolutely no way to distinguish a fertile from an infertile egg without incubating it for some days. All advertisements to this effect are frauds pure and simple. Nor can the difference be found out by breaking open the egg. There is a white spot, the germinal vesicle, in each and every egg laid by hen or pullet, but many an amateur cannot discover it, and he thinks what he does not see is not there. This germinal vesicle looks precisely the same to the naked eye in the impregnated or unimpregnated egg. Under the microscope the difference may be seen. The germinal vesicle in the unimpregnated egg is a simple cell, in the pregnated egg there is a ridge, or row of cells, but several days, and staining fluids are required to prepare an egg for microscopical examination.

VENTILATION OF EGGS IN THE INCUBATOR.

Perhaps there is no subject about which there are more wild theories rampant than the question of ventilation. As one reads the various incubator catalogs, he is surprised at all the so-called wonderful discoveries each manufacturer has made. Nevertheless, nobody ever seems to have made any sort of an investigation that would pass muster in a scientific laboratory.

There has been a constant reiteration of the great necessity of fresh air, but nothing has proved so costly to us as the apparent reasonableness of these theories. For many years we believed this firmly and sacrificed about $2000 worth of eggs to it.

Many an incubator have we built to improve ventilation, but the results have been exceedingly disastrous. In not a single case have we had a fair hatch where any large amount of air was admitted into the machine After some years of experimenting we finally invented a device by which to test conveniently the relative amount of carbonic acid gas under the hen and in incubators. We were very greatly surprised as soon as we tested conditions under the hen. We found the carbonic acid gas under her very great indeed, much greater than in any incubator. We also discovered at once that the incubators with the least ventilation, showed much more carbonic acid gas than those pets of ours with much ventilation. And the hatches from the incubators with poor ventilation proved very, very much the best.

We also had one machine that had been a puzzle for a long time. It was made in a very crude manner by somebody and was a forbidding looking affair. We had purchased it from one of our customers unseen, or we certainly would not have bought it. But we had bought several hatches of remarkably fine chicks from this machine and so we risked it with eggs. We had a fine hatch and it was run many times and never failed us. The machine had a capacity of about 800 eggs and had only one 1-inch opening for ventilation, which was screened with two layers of burlap. When the carbonic acid gas test was applied to this machine, we found it contained by far the greatest amount of any machine in the hatchery. So far it was hardly possible to doubt that too much ventilattion was the cause of many failures. We shut up the ventilators on our machines and stuffed up all cracks and quite remarkable improvements appeared at once. The chicks were much stronger and larger.

We thought perhaps the air-space surrounding the eggs was too large, as even with our best incubators we could not equal the hen in carbonic acid gas. We then built an absolutely air-tight machine of galvanized iron throughout, that had almost no extra air space and no nursery. This would even beat the hen on carbonic acid gas, but we were never able to reduce its moisture much below 90 on the wet bulb, and every hatch proved a dismal failure. But undoubtedly not on account of too much carbonic acid gas, but on account of too much moisture. We found the woodencase with cloth screens necessary to produce an incubator sufficiently dry when all ventilators are closed.

We subjoin tables of the tests on carbonic acid gas evolved both in incubators and under the hens. These tables are the average of a large number of hatches, where practically every fertile egg produced a perfect chick. They are taken from hatches of eggs during the

moulting season, when eggs are not naturally very vigorous. We early found that little is to be learned from successful hatches from very vigorous eggs. They will hatch anyway, and do not reveal the weak points of an incubator. Moreover, a hen was set each time as the incubator was set, with eggs taken from the same lot, and only such hatches are used in this table where both the hen and incubator brought off hatches in every respect alike, even to the relative weight of eggs and chicks. Thus the utmost precaution has been taken to secure a standard hatching table. We believe that conditions which produce perfect chicks from comparatively weaker eggs, must be very nearly ideal. Such are represented in our table, so far as temperature, moisture, carbonic acid gas and structure of machine is concerned. The values obtained were from machines constructed like the one shown on page 4. The table for hens are from a Barred Rock and a Buff Orpington, sitting in roomy nests with straw bottom. It will be seen that the amount of carbonic acid gas varies more or less, as also does the moisture, and accordingly when neither runs higher or lower than any values given, no attention is paid to either carbonic acid gas or moisture in our hatchery. It is not necessary to have these the same every day so long as they come reasonably near this standard.

STANDARD HATCHING TABLE FOR INCUBATORS.

Day of Incubation	Temperature-	Cubic centimeters of air	Carbonic Acid Gas	Wet Bulb	Percent. of Humidity	Minutes Eggs were cooled
1	103			86	49	
2	103			85	47	
3	103			85	47	
4	103			86	49	10
5	103	400	1	85	47	10
6	103	400	1	83	42	10
7	103	320	3	81	38	10
8	103	240	5	82	40	10
9	103	240	5	83	42	10
10	103	240	5	83	42	10
11	103	200	6	82	40	10
12	103	160	7	83	42	10
13	103	120	8	83	42	15
14	103	120	8	85	47	15
15	103	120	8	85	47	15
16	103	80	8	83	42	15
17	103	50	9	84	45	15
18	103	40	10	85	47	15
19	103	40	10	85	47	Eggs pipping
20	103	50	9	92	68	Hatch half out
21	103	40	10	84	45	Hatch all out

RECORD OF TWO HENS

Day of Incubation		1		2		1	2	1	2	1	2
		Vol. Air	Gas	Vol. Air	Gas	Wet Bulb	Moisture	Wet Bulb	Moisture	hen off nest	
1		-----		----		----	--	----	--	x	
2		-----		----		----	--	----	--		
3		240--	5	200--	6	----	--	----	--		
4		240--	5	80--	9	85	47	----	--	x	x
5		240--	5	120--	8	----	--	----	--	x	
6		160--	7	80--	9	----	--	86	49		
7		160--	7	80--	9	87	--	----	--		
8		120--	8	80--	9	----	--	----	--	x	x
9		140--	8½	120--	8	----	--	----	--	x	
10		40--	10	40--	10	----	--	----	--		
11		40--	10	80--	9	----	--	87	--		x
12		30--	15	60--	9½	----	--	----	--		
13		40--	10	50--	9½	85	47	----	--	x	
14		40--	10	40--	10	----	--	84	45		x
15		30--	15	80--	9	----	--	----	--		
16		30--	15	30--	15	----	--	----	--		
17		30--	15	20--	18	----	--	----	--	x	x
18		30--	15	20--	18	----	--	----	--	x	
19		20--	20	20--	20	----	--	Chicks Pipping			
20		20--	20	20--	20	----	--	All through hatching			
21		-----	--	-----	--	----	--				
22	Hen with brood of chicks two days old--			50--	9						

Temperature 102 to 104

The volume of air given in these tables are the number of cubic centimeters of incubator air which it took to cloud one cubic centimeter of lime water. (The first distinct clouding is the point used in the tables.) These are exact measurements and should be used in future investigations, to avoid the confusion of different standards. The figures for volume of carbonic acid gas are an arbitrary graphic representation of its density, as indicated on the piston rod of our air pump. They show relative, not actual values, but most admirably serve its purpose to show the difference between hen and incubator and different days of incubation.

The actual amount of carbonic acid gas present in an incubator, it should be remembered, is also directly dependent upon the number of fertile eggs in a given enclosed space. These tables are not to be used for the purpose of guiding ventilation, in the sense of admitting air into the incubator in case there should be found more gas than our tables show. Keep your incubator closed tightly, no matter how much carbonic gas is found in it. We, ourselves, have not been able to obtain any higher values, and are of the opinion if we could secure

a machine giving higher values, it would be still better, for as will be seen from the tables giving the records of hens, that the amount of carbonic acid gas is much greater there.

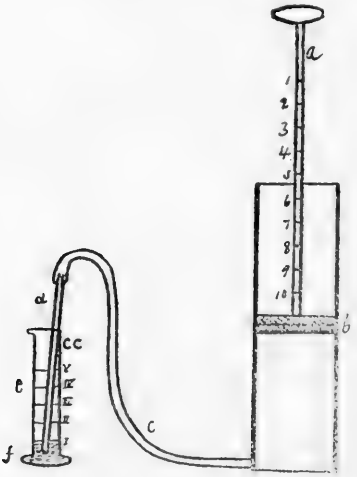
It will also be seen that the amount of gas under the hens is quite variable, depending upon how closely the hen is setting.

We take it, that these investigations, prove, not actually how much gas is necessary to hatch eggs, but that absolutely confined air is of the very first importance in an incubator. If you confine the air in your incubator there will always be more or less carbonic acid gas present.

On these measurements human breath shows clouding at about 20 to 25 cubic centimeters, or 25 volumes of gas on the figures for carbonic acid gas.

It is noticeable also that even the chicks two days old under the hen's wing, live in the presence of much carbonic acid gas.

Notice also that these hens bringing off perfect hatches only left the nest five or six times altogether. In cooling eggs this fact should be taken into consideration.



3. P. Cook's Carbonic Acid Gas Test. Price, $5.00.

a, graduated piston rod (for each fifty cc.) b, air pump; c, rubber tube; d, glass tube; e, five cc graduate; f, limewater.

METHOD FOR TESTING CARBONIC ACID GAS.

Our method consists in withdrawing a certain portion of air within the incubator taken directly above the eggs, and about twelve inches from the front of the machine. A small hole is bored through the frame of the door about one quarter inch in diameter, through which a small rubber tube with a glass end is introduced. This rubber tube is attached to an air pump, holding from 250 to 300 cubic centimeters of air. The piston of the pump is graduated for each 50 cubic centimeters.

After the air is withdrawn from the incubator, it is passed through one-half centimeter of lime water, and the point where the clouding of the lime water begins is noted.

As is well known, this clouding is due to the amount of carbonic acid gas, which has passed through the lime water. The point at the piston is then read, which indicates directly how many cubic centimeters of air have passed through the lime water to effect the clouding.

The piston rod is graduated up-side-down, beginning with 10 and ending with one, so as to indicate directly the amount of carbonic acid gas.

For instance, if the first fifty cubic centimeters of air effect the clouding of the one-half cubic centimeter of lime water, the piston rod will stand at 10, which we designate as 10 volumes of carbonic acid gas present in the incubator. This is, of course, wholly arbitrary, but it serves very well to give an indication of the relative amount of the carbonic acid gas present. What this measurement actually amounts to is this: The fifty cubic centimeters of incubator air contains enough carbonic acid gas to cloud one-half cubic centimeters of lime water, which is equal to 100 cubic centimeters of incubator air clouding one cubic centimeter of lime water.

We suggest that all incubator tests on carbonic acid gas to be made in the future, be made upon this measurement, as it is very convenient indeed, and serves all practical purposes in the best possible way. Some unit of measure will have to be decided upon, and as all our tests have been made on this, it would only confuse matters if any additional standard of measurements were introduced.

The lime water which we use is prepared in the ordinary way, just taking a piece of unslaked lime and dissolving as much of it in water as the water will take up perfectly clear, and using the clear part of the water. We use the ordinary five cubic centimeter graduate. The whole outfit is sold for $5.00 to anyone who is interested in these experiments. It is necessary to clean the graduate after each test, as more or less clouding will be effected, which will interfere with the reading.

If an ordinary rag will not clean it, use a drop of hydrochloric acid, which will clean the graduate instantly, and it should be well rinsed after cleansing.

In all our tests the air was not withdrawn from the incubator until it had been closed for 24 hours.

THE MOISTURE PROBLEM.

There is no end to the theories about moisture in an incubator. There seems to be an almost universal opinion that eggs will be helped by being sprinkled, or by filling the incubator by some means with moisture.

Undoubtedly the moisture problem is a very important one in artificial incubation, and it is by far the most difficult of solution. It is comparatively easy to determine the relative amount of carbonic acid gas under a setting hen, and it is also comparatively easy to secure something of a corresponding amount of this gas in an incubator by reducing the air space surrounding the eggs, but with the moisture problem it is different. It is almost impossible to find out the relative amount of moisture surrounding the eggs under a setting hen. The space is so very small that it is almost impossible to make any test. The wet bulb thermometer is practically inapplicable here. The amount of moisture introduced by the wet bulb would interfere with any correct results of a test.

About the only other method available is the use of the spiral hygrometers, which are very unreliable at best. We have made hundreds of tests of setting hens, using a spiral hygrometer, placing it as carefully as possible, and after reading it transferring it to an incubator, and introducing moisture into the compartment, or withdrawing it until we found a corresponding reading, and then comparing it with our wet bulb instrument.

There would be only one other way of measuring the moisture under the setting hen, and that would be by withdrawing a small portion of air, and by analysis determining the actual percentage of moisture present in it. For this we did not possess the necessary instruments, and it is very doubtful if it would be of very much value. The results which we have obtained have been variable indeed, ranging as low as 35% of humidity, and as high as 60%. It has been impossible to get almost any two readings alike. Perhaps the only actual result that is dependable is the fact that in all cases the humidity of the air surrounding the eggs under the hen was considerably drier than the outside air.

It was also found that the amount of humidity under the hen bears no corresponding relation to the humidity in the outside air. Some of our tests of hens setting practically out of doors, in rainy weather, with the rain dropping over their wings, still showed only about 40° of humidity over the eggs. But to repeat, none of the tests made can be regarded as in any sense absolutely accurate, so we have no clue as far as the hen is concerned, what the amount of moisture should be surrounding the eggs. Perhaps the safest way is to regard the lowest reading the most accurate, as nearly all instruments register higher than actual humidity.

When it comes to the incubator it is easy enough to determine the relative humidity inside the egg chamber. All that is needed is a reliable wet bulb thermometer.

Place it carefully, and read the difference between the dry thermometer, and the wet bulb thermometer, and the amount of relative humidity can be readily determined by the use of psychro-metrical tables published by the United States weather bureau. (A number of so called incubator hygrometers are on the market, which pretend to give a direct reading of the humidity in the egg chamber, but these cannot be used for anything like accurate work. Some of them do not read low enough, and it is doubtful if others are sufficiently accurate. Any hygrometer that does not read as low as 35° is worthless for incubator use, and should not be sold for that purpose.)

For all practical purposes it is much simpler to disregard the actual relative humidity, but carefully note the depression of the wet bulb thermometer. In that way all confusion and difficulty is avoided.

The only method open to determine the right amount of moisture for successful incubation, is by repeated experiments. Our experiments in this line have continued for over six years, and hundreds of hatches have been carefully noted. We have never found a good hatch unless the air in the incubator was comparatively dry. The percentage of about 40° or 45° humidity seems to give the best results, which is equal to a depression of about 18° to 20° on the wet bulb thermometer. Where it is possible we prefer to use 20° of depression for hatching, i. e., 83° on the wet bulb. We have had uniformly good results at this point, provided all other things are right. There is no doubt that a great many incubators, and a great many hatches fail because it is impossible to get the air dry enough. Of course, on the other hand many hatches are spoiled by the air being too dry on account of the excessive ventilation within the incubator chamber. But it was found in our other experiments that there must be practically no ventilation of any kind in the incubator chamber, and the air surrounding the eggs must remain perfectly quiet in order to maintain sufficient carbonic acid gas and prevent the formation of cripples. This makes the moisture problem a most difficult one. Incubators will act as contrary as anything that can be imagined in this respect.

The problem in incubation is to get the air within the egg chamber to run about 83°, wet bulb, without ventilation of any sort. Where this cannot be accomplished the hatch will be more or less a failure. Some incubators we have had we simply could not use at all. Others of identically the same make worked without any trouble. Only a very few that we found needed artificial moisture, when the machine had been made practically air tight.

One of our large machines was a constant puzzle to us. It contained eight compartments holding 2000 eggs. The compartments are all built identically alike. They are all heated in the same manner by one hot water system. They all show the same temperature yet one compartment runs 20% higher in moisture than all the others, and consequently we cannot use that compartment. We

have been unable to determine any reason whatever for this difference. There are certain seasons of the year, however, when all the compartments run alike, and we can use the whole machine. This is simply one of the instances of the many queer actions with which incubators confront us.

We find that a space about twelve inches high from the bottom of the machine to the top is necessary to give sufficient dryness of the air, which has to take up of course the evaporation of the moisture from the egg, and still not become too highly saturated with moisture.

We have sometimes found it quite an improvement to slip a diaphragm, made of thin muslin, between the eggs, and the hot water pipes, thus making two compartments in the machine. The diaphragm should be close to the pipes. Small openings may then be made through the top of the machine into this upper compartment, say one or more half inch holes for every 250 eggs. This has a tendency to cause a very, very slow movement of the air, and as more heat is needed to heat up the incubator through this diaphragm, there is more dry air in the machine than can otherwise be secured. It seems the small opening helps to dry out the air without appreciably affecting the air below the diaphragm.

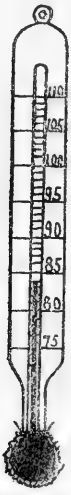
In smaller machines we have found a rather effective way in allowing hot air to circulate around the heater, and allowing it to open into the upper compartment of the machine. This makes the circulation of the air much slower since it has no outlet, but it seems to secure the dry atmosphere, which is so very essential in the egg chamber.

The moisture in the air of the incubator room has no effect on the eggs in the machine. An incubator with ventilators open will usually register much drier on blustering rainy days than on hot, dry, or sultry days. In warm weather the incubator ventilators do not work at any rate, for if there is not much difference in the temperature outside the machine, no air will pass through. It may be given as a safe rule never to put water in an incubator, on hot sultry days. If ever any moisture is needed, it is in winter, or on windy days. Those are the times when the incubator is actually too dry. This will sound strange, to the inexperienced, but place a reliable hygrometer in the incubator on hot, dry days, and you will find a very high humidity. The opposite will be found on cold days, even if they are rainy. More air is sucked through the incubator on cold, windy and blustering days, which causes it to be excessively dry. Sprinkling the floor of the incubator room has not the slightest effect on the moisture within the machine. The effect of too much moisture in the incubator will be that many chicks are dead in the shell, as many as one half or more sometimes.

A rough distinction may be made in this way: If the chicks that hatch are scrawny little things with protruding entrails, or unabsorbed yolk, there was too much ven-

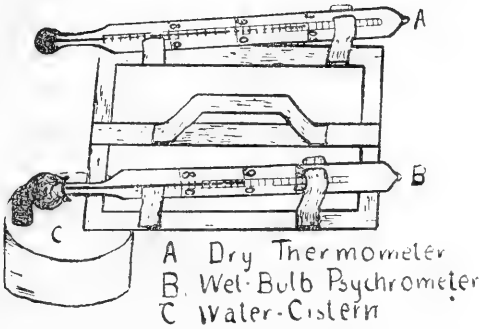
tilation. If the chicks that hatch are fairly good and large in size, the chicks dying in the shells is due to too much moisture. Both faults cause chicks to die in the shell, and both must be avoided. However, it is safe to say ten times as many chicks die in the shells from too high humidity, i. e., too much moisture, than for lack of it.

If moisture is actually needed, the best way to introduce it is a wet sponge placed on the eggs. Water pans may be placed in the bottom, but this does not usually have much effect.



2. P. Cook's simplified Hygrometer.

Price, $1.00.



1 P. Cook's continuous reading Hygrometer. Price, $3.00.

DIRECTIONS FOR USING P. COOK'S HYGROMETER.

Our hygrometer consists of two accurate thermometers, one of which has a muslin wick connected with a water cistern, attached to it. The whole instrument is placed in the machine like an ordinary thermometer. The evaporation of water from the wick around the bulb of one thermometer causes this bulb to cool in proportion to the amount of evaporation. The drier the air in the incubator, the more rapidly will it evaporate water from the wick and thus cause the wet bulb to read lower than the dry bulb thermometer. Indirectly, the difference between the two thermometers indicates the dryness of the air. This is the method used in the U. S. Weather Bureau, and it has published elaborate tables from which

the relative per cent of humidity can be learned if once the depression of the wet bulb thermometer is known. We print here a part of these tables as far as they are of use for incubator purposes. For instance, if the dry bulb stands at 103 and the wet bulb at 83, there is twenty degrees difference, i. e., there is twenty degrees depression on the wet bulb. The wet bulb thermometer is technically called a psychrometer. From the table it will be seen that there is 42 per cent relative humidity in this case. Or if the dry bulb registers 100 degrees and the Psychrometer 82 degrees, there is 18 degrees depression, and it is found from the table that in this case there is 46 per cent humidity.

PSYCHROMETER TABLES.

Temperature of Dry Thermometer		Degrees of Depression of Psychrometer							
		16	17	18	19	20	21	22	
98	Relative Humidity	50	48	45	43	40	38	36	Relative Humidity
100		51	49	46	44	41	39	37	
102		52	49	47	45	42	40	38	
103		52	49	47	45	42	40	38	
104		53	50	48	46	43	41	39	
106		53	51	49	46	44	42	40	

For practical purposes it is much easier, however, to disregard these moisture percentages. It is enough to know that when your thermometer reads 103 degrees and the Psychrometer 83 to 85, your machine is working properly and no further attention need be paid to it.

Ordinarily, if an incubator is once started right, and our other instructions for closing the ventilators, etc., have been followed, there will be no need to use a hygrometer, as the moisture does not generally vary much during a hatch. Nevertheless, it will soon pay to be in possession of a hygrometer, but as our larger instrument costs three dollars, it is too costly for the man who has only a small machine. We have, therefore, designed a much cheaper instrument, which is just as reliable, but takes a little more trouble to use it. This is simply an accurate Thermometer reading down to 75 degrees. A thin piece of muslin is tied around the bulb, this is dipped in luke-warm water and then inserted into the incubator, through a hole bored in the door. It is left there for ten minutes and then partly pulled out to see how low it reads. Its lowest reading, just before the muslin is completely dried out is its correct reading. A number of readings should be taken, the lowest one is the most correct. The incubator should not be opened be-

fore inserting the Psychrometer. Remember the difference between it and your thermometer indicates the moisture. If your incubator stands at only 100 degrees, then 80 degrees on the Psychrometer indicates proper hatching humidity. It is twenty degrees difference that is required. Use your table unless your incubator stands at 103 degrees. The simplified instrument is sold for $1.00, and will be found a most excellent help. Only one instrument is needed no matter how many incubators are used, as moisture does not need to be taken oftener than in the beginning and two or three times during the hatch.

We are aware that these directions require much drier air thany many manufacturers advise, but we have inquired among many hatchers and we have not heard of one of them that has succeeded in securing good hatches at any other percentages the great claims of some hygrometer makers notwithstanding. It should be remembered however, that our figures are for incubators with perfectly still air, i. e., without any ventilation. Still air is not nearly as drying as air in motion.

From our standard hatching table it will be seen that during the exclusion of the chicks we allow 92 on the Psychrometer. This is normal and need not be changed unless chicks are breathing heavily or standing with their mouths open, This indicates too much moisture, as often as too much heat. Ventilators must then be opened, or if the machine has no ventilators, open the doors for a minute and let the moisture escape. As soon as the hatch is over, see that enough air is admitted into the machine to dry out and fluff up the chicks properly.

Sprinkling the eggs will never do them any good; its only effect is to chill them, and if they hatch at all, they hatch in spite of it. In fact nothing that is done to the eggs for a few minutes during the last week, helps them in any way. We seldom ever find any need of moisture during hatching time, only if something is seriously wrong with the incubator moisture will help to overcome its defects. Shut your machine tight until pipping time, and do not open it till chicks begin to show signs of the need of more air.

Some Typical Tests of Moisture Under Setting Hen.

7 a. m. Outside air near hen's nest temperature 52 degrees, moisture full saturation or 100 per cent, moisture under the hen, 49 per cent. 12, noon, temperature outside, 74 degrees; moisture 58 per cent; moisture under the hen, 40 per cent. 5 p. m. Temperature 66, moisture 61 per cent. Moisture under the hen 40 per cent. In all the numerous tests we have made, we always found much less moisture under the hen than in the air around her. As she heats the air in her nest, it would naturally register drier than the outside air, unless she supplied moisture from her body, but as all tests show this is not the

case. The hen does not sweat through her skin and it seems that her feathers asbsorb the evaporation from the eggs. We had one White Rock hen sitting on damp ground and the moisture under her always ran between 60 to 65 per cent, but all the germs rotted in the shell, only three lived till the 21st day, but did not hatch. The other tests above given are from hens that brought off normal hatches.

Where we made daily tests for moisture, the hens always brought off poor hatches, due no doubt to disturbing the hens too much.

HELPING CHICKS OUT OF THE SHELL.

There is little use to help chicks out of the shell when they have not been properly incubated, but in the moulting season we have sometimes found that the stragglers can be helped to advantage. A chick should never be helped too early, and unless it is plump and in every respect perfect when helped out, it is not worth anything In the time that eggs are naturally fertile, all chicks will usually pop out without any help. Chicks too weak to get out then is a sure indication of faulty incubation. No chicks should be helped out until the hatch is nearly over.

TYPICAL WEIGHTS OF A GOOD HATCH.

100 Fresh eggs, 11½ lbs.

100 clear eggs 10 ibs., 6 oz. (15 days in incubator), at 85 Psychrometer reading.)

100 chicks 8 lbs., 1 oz.

GOOD HATCHES ATTRIBUTED TO WRONG CAUSES.

Here it is well to point out that frequently good hatches are attributed to wrong causes. Mr. "A" puts a pan of water under his eggs, the last few days, or sprinkles them or gives more ventilation, etc., and has a good hatch. He concludes this is the thing to do. But it may have had nothing whatever to do with the good hatch. The fact is that strong eggs hatch well in spite of a good many things. We dropped a tray of eggs once. Two-thirds of the eggs cracked. (16th day of incubation.) We patched them up with celloidin and they all produced remarkably strong chicks. Nevertheless, cracking eggs is not the best way to hatch them. It should be remembered, the critical period of incubation are the first six days, and it may almost be said, that it does not matter what happens after that. Certainly eggs will stand quite a lot of abuse after that and still hatch well. So far as ventilation is concerned, it may be said that most arrangements do not work, which is their recommendation. If the ventilators of the incubator actually get to work, then they produce mischief. If the incubator is placed in a room where the air is still, there is but very little ventilation going on inside the machine, but if the air of the room gets in motion,

it will be sucked through the ventilators of the incubator, and a spoiled hatch will follow. Too much ventilation produces small, scrawny chicks with protruding bowels, etc. A spoiled hatch from too much ventilation is about the sickliest sight imaginable. The glowing claims of incubator manufacturers that their machines change the air ever so often, are fortunately not often true, but when they are true their machines fail to hatch.

It is not known whether the amount of carbonic acid gas has anything to do directly with hatching, for it varies greatly under different hens. It may be that all that is required is absolutely still air in the incubator. In still air the gases do not diffuse very readily. We found in one machine that had eggs only on one tray, twice as much carbonic acid gas as on the other tray without eggs. As a rule, there is a little more at the bottom than near the top of the machine, which is natural, since the carbonic acid gas is heavier than air. The fact remains, however, that eggs under the hen are incubated under the pressure of a very large amount of carbonic acid gas. This was found true even of a tiny bantam hen that weighed only about one pound, but the percentage of carbonic acid gas under her was as great as under the large hens. This proves conclusively, that there is no so-called ventilation under the hen, nor any diffusion of the natural gases, or the carbonic acid gas would have been carried away.

The chief value of these measurements, as we regard it, is in the fact that they pointed out the right way to build an incubator, i. e., one that surrounds the eggs with still air, and thus produces conditions similar to those under the hen. There is, of course, no reason to believe that carbonic acid gas itself helps the hatching. It is a waste product of the respiration of the embryo but embryonic respiration is a decidedly different process from respiration of the full grown hen, and a large amount of carbonic acid gas may not be detrimental, or it may have a sort of symbiotic action, but such consideration we may leave to the professional biologist.

Ordinarily the user of the incubator need not test the carbonic acid gas. Let him follow our directions in constructing his machine, and he will not generally experience trouble. However, the carbonic acid test is the only reliable guide to the ventilation.

METHOD OF HATCHING IN P. COOK'S MAMMOTH HATCHERY.

(The method here given has reference to incubators sold commonly to the public, as this will be of great use to persons who already possess incubators. The principle is exactly the same as that followed in Mr. Cook's own mammoth machines.)

The first thing that is done is to see that the incubator is in good working order, the lamp burning properly and lamp fountain not leaking and thermostat in perfect

order. Then the door is examined, and if it does not fit air-tight, strips of felt are nailed around the edges, so as to make it fit tight. One or two layers of burlap or cotton batting are placed in the bottom of the machine to make it warm enough below the eggs.

The temperature at the bottom of the incubator should never be allowed to fall much below 90 degrees. If it is colder than that cripples are sure to result. If the machine has nursery drawers, it is best to fill these up with straw or cotton for the first two weeks at least. If the machine has no nursery the temperature at the bottom of the egg-tray should be at least 100 degrees.

When the machine is heated up, the thermometer is placed in position where the top of the eggs would come and the regulator adjusted to hold the machine at 103 degrees. The machine is kept going for a day or so with ventilators open in order to dry it out. Then a hygrometer is also placed into it and watched till it sinks to 83 degrees. It may take several days to dry out the machine sufficiently. Then the ventilators are all closed and the hygrometer read again. If it stands between 80 and 83 degrees, it is all right. If it stands above that, the machine must be further dried out. There is not much probability of a good hatch if the hygrometer at the beginning of a hatch remains as high as 87 for more than a day.

We had to run one machine for three weeks, before it became dry enough for hatching. If you cannot make your machine dry enough do not waste your eggs on it. We have never come across a machine too dry, if all its ventilators are closed.

Next the egg trays are taken and fitted with a mechanical turning rack as described elsewhere. The eggs are placed on the tray with the turning rack in position. They are laid flat on the side and not crowded. You can get more eggs into the machine by standing them on edge, or even by doubling them up, and the strong eggs will hatch that way, but the weaker ones will die in the shell. But remember, what is not good for the weaker eggs, is no benefit to the stronger ones either. Do not begin the poultry business by abusing your chicks before they are born. It is knocking your profits with a club on the head.

When the eggs are on the tray, thermometer and hygrometer are then placed in position and all outgoing ventilators are shut tightly. The best way to do this is to stuff a tuft of cotton into the holes. It need not be stuffed very tightly. Those machines that have the air intake over the lamp or around the heater, need only to have the outlets closed, for as soon as these are closed no more air passes through them into the machine. On other machines all ventilators must be closed.

The eggs are turned by the mechanical turner after six hours and after that every twelve hours apart, but under no conditions must the machine be opened for the first 72 to 84 hours.

On the morning of the fourth day the incubator is opened for the first time and the eggs are taken out and aired for about ten minutes. They are also tested for infertiles at this same time. Then the eggs are returned to the incubator and turned mechanically twelve hours after this without opening the machine. At the next twelve hours the eggs are aired again for ten minutes and so on till the twelfth day. After that they are aired 15 minutes, but never under any circumstances is the machine opened more than once a day. This method, ventilators closed, eggs aired only once a day, but turned twice daily, and 83 degrees on the psychrometer, we have found an unfailing cure for chicks dying in the shell. But no one of these details must be omitted, or the hatch may be spoiled.

On the 18th day the machine is closed, but small ventilators may be left open, if your incubator room is free from drafts. There will be no trouble, if these directions have been followed, with chicks getting out of the shell. There will be a downy lot of fine fluffy balls, as lively as can be wished in your machine next morning.

In one respect nothing is so important as this closing of the ventilators, especially if your incubator stands in a room that has the least draft in it. Eggs will not hatch to the best advantage except in absolutely still air. For that reason taking eggs out of an incubator twice a day is detrimental. Only the strong eggs will stand it, the weaker ones will die in the shell. Do not worry about the need of fresh air. There is far more oxygen in the incubator than the eggs will ever need, as is shown conclusively by the carbonic acid gas test. It is true the carbonic acid gas may be a very variable quantity, depending upon the number of eggs in the incubator, etc., but the still air is the thing of highest importance. We know of hundreds of incubators that miserably failed to hatch with the manufacturer's fresh air directions which became first-class hatchers by simply nailing up the ventilators and using a mechanical turning tray.

During the proper season of the year we find that generally every germ alive at the 17th day hatches a perfect chick. Even in the molting period we have had many perfect hatches by this method, but occasionally some chicks die in the shell then, however, we seldom find over ten per cent of dead chicks even at that time. Of course no account is taken of germs that die before the seventeenth day. Sometimes there are many of these, but the fault lies with the eggs in such cases and neither hen nor incubator could hatch them.

HATCHABLE EGGS.

There is a large difference of opinion as to which is to be considered a fertile egg. Breeders in selling eggs usually follow the practice of guaranteeing a certain percentage of fertile eggs, meaning that they will replace any perfectly clear eggs below their guarantee. There are, however, always a certain number of eggs with im-

perfect germs or weak germs, or whatever they may be called. None of these imperfect germs can be expected to hatch. Neither hen nor incubator could do anything with them. Some of these germs do not develop any farther than simply to make a bloody streak through the yolk of the egg. Others grow longer. Some live as long as the 13th and 14th day. In all these cases the germ of the egg has been faulty, and it is impossible to hatch such eggs. The proportion of these eggs depends upon the vigor of the fowls, and to some extent also on the season of the year. It is a good plan to test all the eggs in an incubator on the 17th day. All of the embryos dead at that time should be removed. If all the chicks alive in the shell on the 17th day hatch, the hatch may be called a perfect hatch, as that is all that can possibly be expected to hatch. But the great great difficulty with incubators has been that the chicks die in the shell after the 17th day. If any large proportion of chicks die in the shell after the 17th day we consider it the fault of the incubators, not of the eggs. After chicks have been developed up to that stage they would probably hatch if they had been incubated right. Our experience has been that if everything has been right during the period of incubation practically all the chicks alive at the end of the 17th day will hatch.

MAMMOTH AND COMPARTMENT MACHINES.

We have spent a great deal of money in the attempt to build a large compartment machine heated by only one heater and capable of continuous hatching. Such a machine is evidently very desirable for a large hatching plant, but we have met with only moderate success in this direction. It is easy enough to construct a machine with any number of compartments to hatch properly if the entire machine is filled with eggs at the same time. Then all the compartments require the same amount of heat and the entire machine can easily be regulated by one thermostat. But difficulty arises when eggs of different periods of incubation are placed in different compartments. The eggs much ahead generate a good deal of their own heat and have to be in cooler compartments. It is very difficult to remove surplus heat from such compartments without interfering with the necessary moisture and carbonic acid gas conditions. The easiest way to remove heat from a compartment would be by letting it escape through ventilators, but this is not permissable, for ventilation spoils the hatch. Stop cocks or other methods must be used, which involve a great deal of expense. It can no doubt be done, but we have abandoned it for our own use. We have found it much the cheaper method to build different incubators. One machine can be used for the first week, another for the second and a special machine can be built for the last week with conveniences to take care of the chicks for hatching.

Our machines are 22 feet long and four feet wide and in this size we have found no need for more than one thermostat for each machine. Each machine is built with eight compartments independent of each other.

NURSERIES.

We have used machines with nurseries in nearly all our experiments. We do not know of how much real advantage they are. In a big hatch chicks seem to have a little more elbow room as they are away from the shells. Many machines are made with drawers, but these are not always an advantage. If a machine is made with drawers, it should be so made that the egg tray is placed on the drawer and always comes out with it. If the drawers are made to slide in under the tray, there is always trouble. As soon as the drawer is pulled out a number of chicks will jump over the back of the drawer and others raise their head and you can neither shut nor open the machine or get the chicks. We prefer no drawers at all unless the egg tray comes out with the drawer.

DISINFECTING INCUBATOR.

At least every third hatch an incubator should be thoroughly disinfected. The trays and bottom should be thoroughly cleansed. They can be washed with almost any good disinfecting fluid or sulphur may be burned in it. This last is the most effective method, but it will require some days of airing before you can get the sulphur out again. However, it is not necessary to get all the sulphur smell out. We have had good hatches with the sulphur smelling strongly all during the incubation.

The incubator is a splendid hatcher of all kinds of germs and white diarrhea may be caught in the incubator.

On the other hand, the incubator should not be blamed for chicks dying after they are some days old. If the chicks are big and strong when hatched, you may be assured that the incubator has done its part. After that the fault lies with the brooding.

INCUBATOR HOUSES AND CELLARS.

Incubator may be placed in any room that will shelter it, but a basement or cellar that is light and cheery, and not too damp is very desirable, for the temperature of such a place is not subject to as much variation as an ordinary room. The most desirable temperature for an incubator room is between sixty and seventy degrees. The most important item, however, is, that it be well ventilated, but absolutely free from draft. Nothing works so much mischief in an incubator room as drafts. In a perfectly quiet room it is not always necessary to resort to the mechanical turning tray. Eggs will fairly well

stand opening the machine twice a day for turning, only for the one turning the eggs must be returned as soon as possible to the machine. But even in the best incubator room a strict adherence to our method will be found to pay well.

A cellar three feet deep with cement floor and walls and the rest of the building above ground, is the ideal for an incubator house. It should be kept dry. Never sprinkle the floor.

It is immaterial whether lamps, gas or coal, etc., is used for heating incubators, but the fumes should be carried off through chimneys.

CHICKS DYING IN BROODER.

It is not always easy to raise a big flock of chicks artificially, and while it does not belong here, we may as well point out one great means of saving chicks. People have become so accustomed to the necessity of disinfection that they believe if they could only kill all the germs, their chicks would do well, but they forget that there are as many if not more, beneficial germs as there are disease germs. Disinfection kills both the good and bad germs. The real remedy is not always more disinfection, but better natural conditions for the chick. Prof. Metchnikoff, head of the Pasteur Institute in Paris hatched and tried to rear chicks under absolutely germ-proof conditions, but found that his chicks would dwindle away and die in a few weeks. Afterwards he allowed his chicks to come into contact freely with the ordinary dunghill bacteria and they were thriving as they should. The intestinal canal is inhabited by a number of bacteria that aid materially in digestion, and the entire absence of these causes many chicks to die apparently without any cause.

One of our neighbors, a famous breeder of Barred Rocks, has for years claimed that the only sure way to prevent white diarrhea in chicks is to feed them a liberal supply of maggots. He has been a steady customer for the rotten eggs from our hatchery. He exposes them to the flies for a day and then lightly buries them. Shortly there is as big a lot of wrigglers as any old hen would want. He feeds these maggots regularly, and certainly raises magnificent birds on them. It is probably safest to use maggots thus produced under ground, for if the eggs were not buried, there might be ptomaines developed.

In everything the poultryman should remember that he cannot far transgress nature with immunity. If chicks are once well hatched, then look to your brooding system.

Successful Incubation

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