# United States Patent

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[54] **APPARATUS FOR SORTING FERTILIZED AND UNFERTILIZED EGGS**
**2 Claims, 2 Drawing Figs.**


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[51] **Int. Cl.** ..... **B07c 5/344**
[50] **Field of Search** ..... 209/73, 74, 75, 81; 324/71, 71(Voltage), 61(Misc.), 61(NEP)



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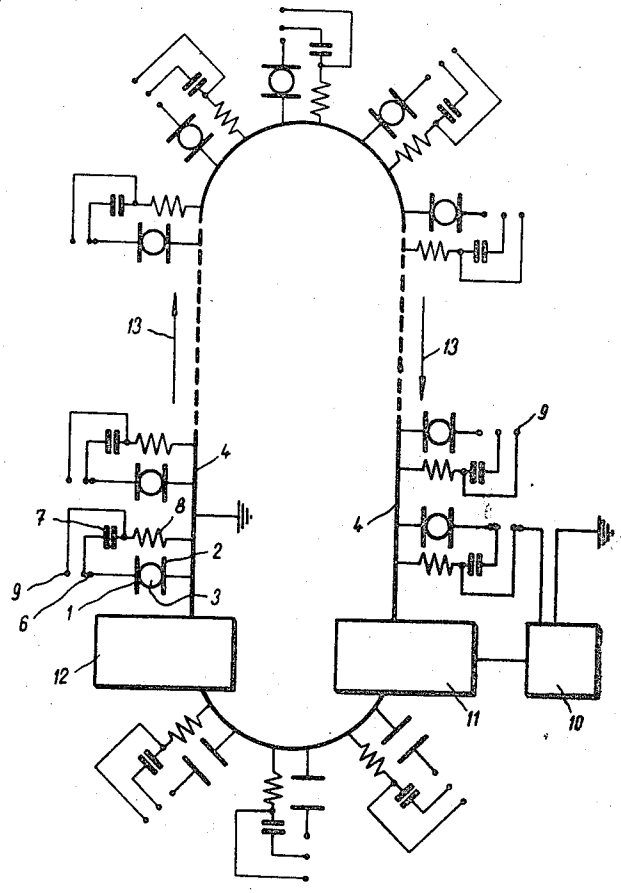
**ABSTRACT:** An apparatus for sorting fertilized and unfertilized eggs according to the electrical potentials arising between embryo and yolk during incubation. An endless conveyer with an upper and lower branch carries a plurality of pairs of electrodes, each pair being adapted to receive an egg. In series with each pair of electrodes there is connected through a switch a capacitor and a resistor. While the eggs move over the upper branch, the switch is closed and the capacitor charges to the potential picked up by the electrode. The switch is opened at the end of this branch and the capacitor stores the respective potential value. At the end of the lower branch over which the egg travels in reversed position, the switch is again closed. Since turning the egg around its long axis by 180° causes the embryo to float to the uppermost surface of the egg, the electrodes pick up another potential value. By closing the switch a voltage difference corresponding to the embryonic potential is formed across the resistor which can be measured with an electrometric millivoltmeter. The resulting signals control an electromechanical device for sorting fertilized and unfertilized eggs into separate lines.

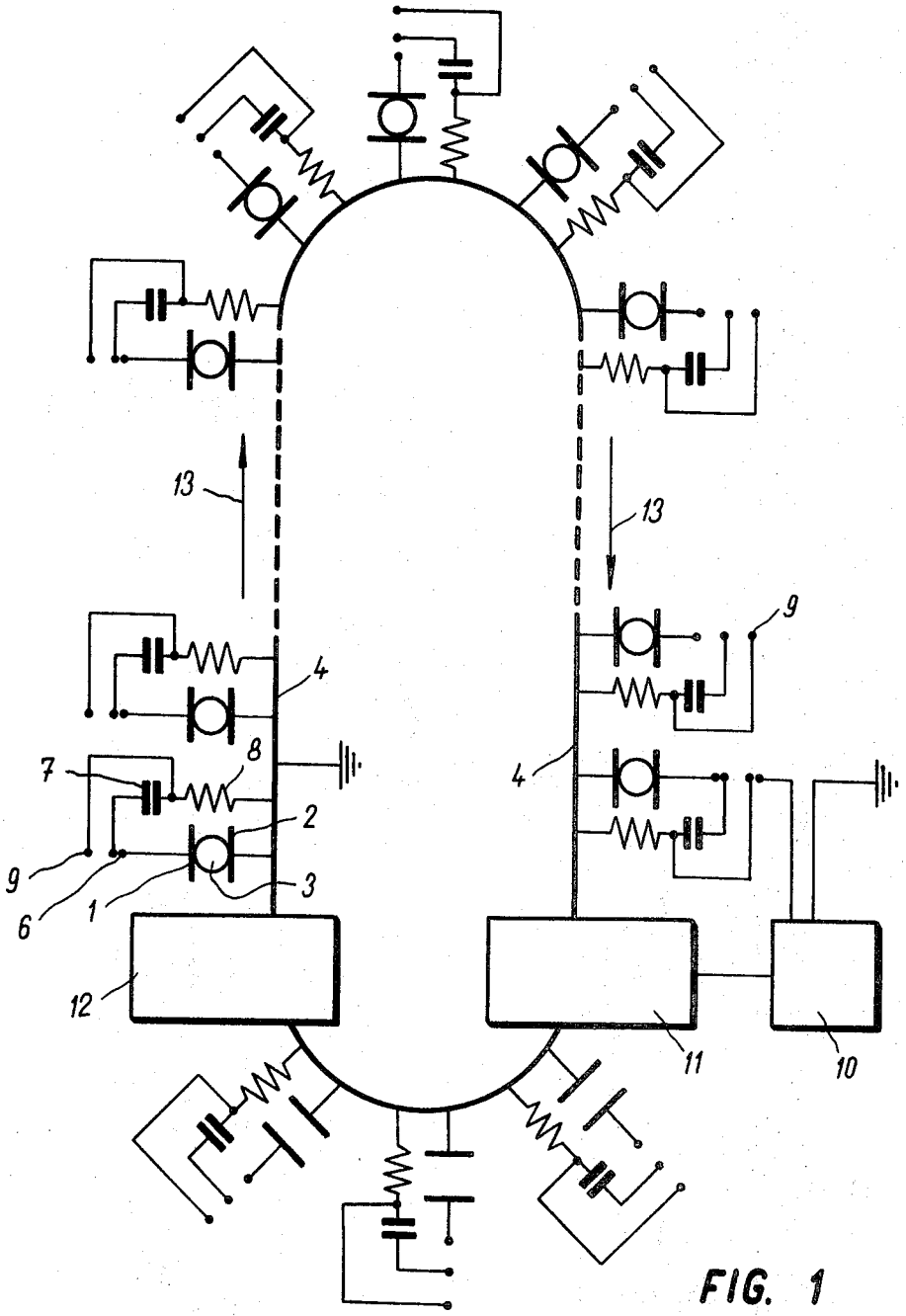



FIG. 1

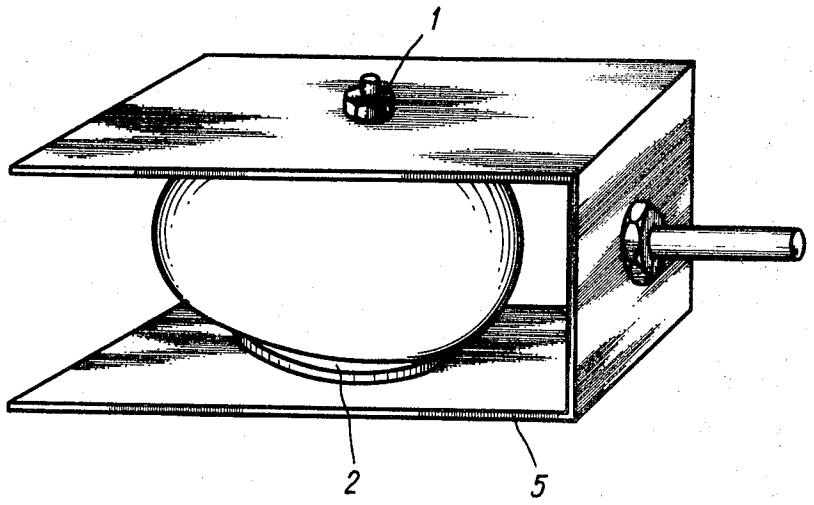



FIG. 2

# APPARATUS FOR SORTING FERTILIZED AND UNFERTILIZED EGGS

## BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to an apparatus for sorting fertilized eggs during incubation making use of electrical potentials produced in fertilized eggs.

2. Description of the Prior Art

Whether a hen's egg is fertilized and whether its development in an Incubator proceeds normally has hitherto been ascertained only on the fifth day of incubation by transilluminating the egg. However, since the end of the century it has already been known, as disclosed by Hermann and Gendre in 1855, that the development of a chicken embryo is accompanied by characteristic electrical potentials which can be recorded even through an intact shell, as shown by Vorontsov and Emchenko in 1947, provided a suitable technique is used for the measurement. In this manner it becomes possible to differentiate between a fertilized and an unfertilized egg already after 48 hours of incubation, and to obtain a certain information about the speed of the development. This method has not been employed in poultry breeding, so far, because it is too time consuming.

It is a general object of the invention to provide an apparatus which makes practical use of the above findings.

Electrodes connected by means of patches soaked with a saline solutions to the egg pick up potentials generated at the shell surface (diffusion potentials due to unequal mobilities of ions in the shell pores, local differences in shell density and in the properties of the adhering membranes) as well as potentials arising within the egg (between yolk and egg white, between the embryo and yolk or between different parts of the embryo). As proposed by Vorontsov and Emchenko (1947) there two potentials can be separated from each other by taking advantage of the fact that during the first days of incubation the embryo always floats to the uppermost part of the egg. The overall potential difference $V_1$ at the end of the initial recording period of 1 to 3 minutes is, therefore, equal to the sum of the contact ($V_c$) and embryonic ($V_e$) potentials,

$$V_1 = V_c + V_e \qquad (1)$$

After turning the egg with the electrodes through 180°, the contact potential remains unchanged but the embryonic potential gradually reverses its polarity with respect to the electrodes as the embryo attains its position beneath the uppermost part of the shell again. At the end of a two-minute reversal period the potential $V_2$ can thus be expressed as

$$V_2 = V_c - V_e \qquad (2)$$

From equations (1) and (2) one obtains

$$V_c = \frac{V_1 + V_2}{2}, \quad V_e = \frac{V_1 - V_2}{2}$$

While embryonic potential displays characteristic changes during development, the contact potential assumes random values ranging from −5mV to +5mV independently of the duration of incubation. This indicates that the potential $V_1$ approaches the value of the embryonic potential with an error usually not exceeding 3mV. For exact measurements of the embryonic potential the egg reversing technique is indispensable, however, after 48 hours of incubation, the voltage attains only values between 2 to 5 millivolts. The main source of difficulties arising if this method is applied under practical conditions lies in the slow stabilization of the contact potential and in the slow movement of the embryo inside the egg. These factors determine the speed of the measurement. It takes 60 to 180 seconds before the initial value of the measured potential (electrodes and contact potential) becomes stabilized, and it takes another 60 seconds before the new value of the potential after turning of the egg is attained.



## SUMMARY OF THE INVENTION

It is a specific object of the invention to eliminate this drawback by using a simple memory element to store the value of potential $V_1$ until it can be compared with the potential $V_2$.

To achieve this object the invention provides an apparatus comprising an endless conveyer with an upper branch and a lower branch carrying a plurality of electrode pairs. The eggs to be examined are inserted and clamped between these pairs of electrodes, one egg per pair, at the beginning of one of the branches of the conveyer. A capacitor and a resistor are connected in series with each pair of electrodes through a switch. The apparatus further comprises a device for opening the switch at the end of the first branch and closing it again at the end of the second branch. One end of the resistor is connected with one electrodes of the pair and earthed, while the other end of the resistor facing the capacitor is connected with a contact which becomes associated with a measuring device at the end of the second branch when the egg reaches the end of the second branch of the conveyer. The measuring device becomes thus connected a-cross the resistor of the RC circuit at a moment when the switch is closed and the potential $V_1$ formed on the capacitor during the charging period is compared with the potential $V_2$ picked up by the electrodes in the reversed position of the egg. The capacitor is used as a simple memory element storing the value $V_1$ for a later comparison with the actual value $V_2$.

## BRIEF DESCRIPTION OF THE DRAWING

The above and other objects of the invention and its various features will be best understood from the following specification to be read in conjunction with the accompanying drawing illustrating a preferred example of embodiment.

In the drawing:

FIG. 1 illustrates a conveyer with the main elements of a measuring circuit; and

FIG. 2 illustrates an example of arranging a pair of electrodes for inserting an egg therebetween.

In accordance with the invention the measuring time is shortened in a simple manner by using a large number of electrode pairs carried by an endless conveyer belt. Each electrode pair is connected to a capacitor storage circuit. The differential potential is ready on an amplifier connected with an amplitude discriminator and with an electromechanical switching device for placing fertilized and unfertilized eggs on separate transport means.

The invention will now be explained in more detail referring to the accompanying FIGS.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in FIG. 1, the apparatus in accordance with the invention employs a conveyer 4 which may be of the belt or chain type, or any other suitable construction. The upper and lower branch of this conveyer extend in an approximately horizontal position. On the conveyer there is provided a plurality of electrodes 1, 2 forming pairs of electrodes between which an egg can be clamped. At the beginning of one branch of the conveyer 4 there is an egg inserting device 12 where eggs 3 to be tested are placed between the electrodes 1, 2.

FIG. 2 shows an example of embodiment of a pair of electrodes for this purpose. This embodiment employs a yoke 5 made from an electroinsulating material carrying the electrodes 1, 2. These electrodes are conveniently constructed as nonpolarizable Ag-AgCl electrodes. Each of the pairs of electrodes 1, 2 is connected through a switch 6 in series with an RC circuit comprising a capacitor 7 and a resistor 8. The electrode 2 and one of the leads of resistor 8 are grounded, together with the conveyer 4. The second lead of the resistor is connected with a contact 9. At the end of the second branch of the conveyer 4 the contact 9 is connected to a measuring device 10 which controls a sorting device 11.

The conveyer is moved in the direction of the arrows 13.

In the arrangement illustrated in FIG. 1 the upper branch of the conveyer 4 passes first through the egg inserting device 12 in which eggs are placed between the electrode pairs 1, 2, one egg per electrode pair. During the entire time in which an egg is on the upper branch of the conveyer 4, a circuit which includes the grounded conveyer 4, the electrode 2, the egg 3, the electrode 1, the closed switch 6, the capacitor 7 and the resistor 8, is closed.

The speed at which the conveyer 4 moves and its length are arranged so that there is sufficient time for the potential $V_1$ of the egg 3 to become stabilized. Capacitor 7 becomes charged to the potential $V_1$ of the egg 3. As soon as the egg reaches the end of the upper branch of the conveyer 4, the switch 6 is opened. After the egg 3 has reached the lower branch of the conveyer, its position is turned through 180° in comparison with the preceding position on the upper branch of the conveyer 4. Electrode 2 is now in contact with the upper surface of the egg 3, and electrode 1 is in contact with the lower surface. In this position and with the switch 6 opened, the egg travels on the lower branch of the conveyer 4. During this time, the embryo becomes again stabilized in its new position, and there appears on the electrode a potential differing from the previous potential when the egg travelled on the upper branch.

Close to the entry of the sorting device 11 the contacts of the switch 6 are again closed, and the contact 9 is connected to the measuring device 10. Thus, electrical current begins to flow through the resistor 8 of the RC circuit 7, 8, and the electrometric device 10 records the voltage drop produced across the terminal of resistor 8 which correspond to the potential difference $V_1 - V_2$. If the egg was fertilized, a rather large voltage drop can be recorded. After amplification, the obtained pulse is introduced into an amplitude discriminator. If the pulse voltage exceeds a predetermined threshold value the egg is considered to have been fertilized, and the electromechanical switching device of the transport path in the sorting device 11 places the egg which just leaves the conveyer 4 on a nonillustrated conveyer of fertilized eggs. If the produced pulse does not reach this amplitude, the egg is considered to be unfertilized, and the electromechanical switching device places such an egg on a conveyer of unfertilized eggs. If required, several sorting levels may be introduced.



Using a conveyer for 120 eggs moving through one position per second, it is possible to sort out 25,000 eggs in one shift.

The device in accordance with the invention permits on the one hand to stabilized the position of the embryo in the egg, on the other hand, due to the fact that measurement is accomplished in two positions differing by 180°, any interfering voltages produced by nonuniformities of the shell of the egg, or for some other reasons, are balanced so that the operation of the apparatus is completely reliable.

I claim:

1. An apparatus for sorting fertilized and unfertilized eggs using electrical potentials developed in fertilized eggs during incubation, comprising:

an endless conveyer with an upper and a lower branch;

a plurality of pairs of electrodes, each adapted to receive an egg held at opposite sides by the two electrodes;

switch contacts;

one of the switch contacts connected with one electrode of the pair of electrodes and the other contact connected with a combination of a capacitor and a resistor;

means for opening the contacts of the said switch at the end of the upper branch;

means for closing the contacts of the said switch at the end of the lower branch;

a third separate contact connected with the end of the resistor facing the capacitor and adapted to contact a measuring device so as to bring it in connection across said resistor.

2. An apparatus as claimed in claim 1, comprising a sorting device controlled by signals from said measuring device.