

July 8, 1969

H. SCHÄFER  
ARRANGEMENTS FOR SORTING IMPERFECT SHEETS OF MATERIAL  
FROM A WEB OF MATERIAL  
Filed March 24, 1967

3,454,160

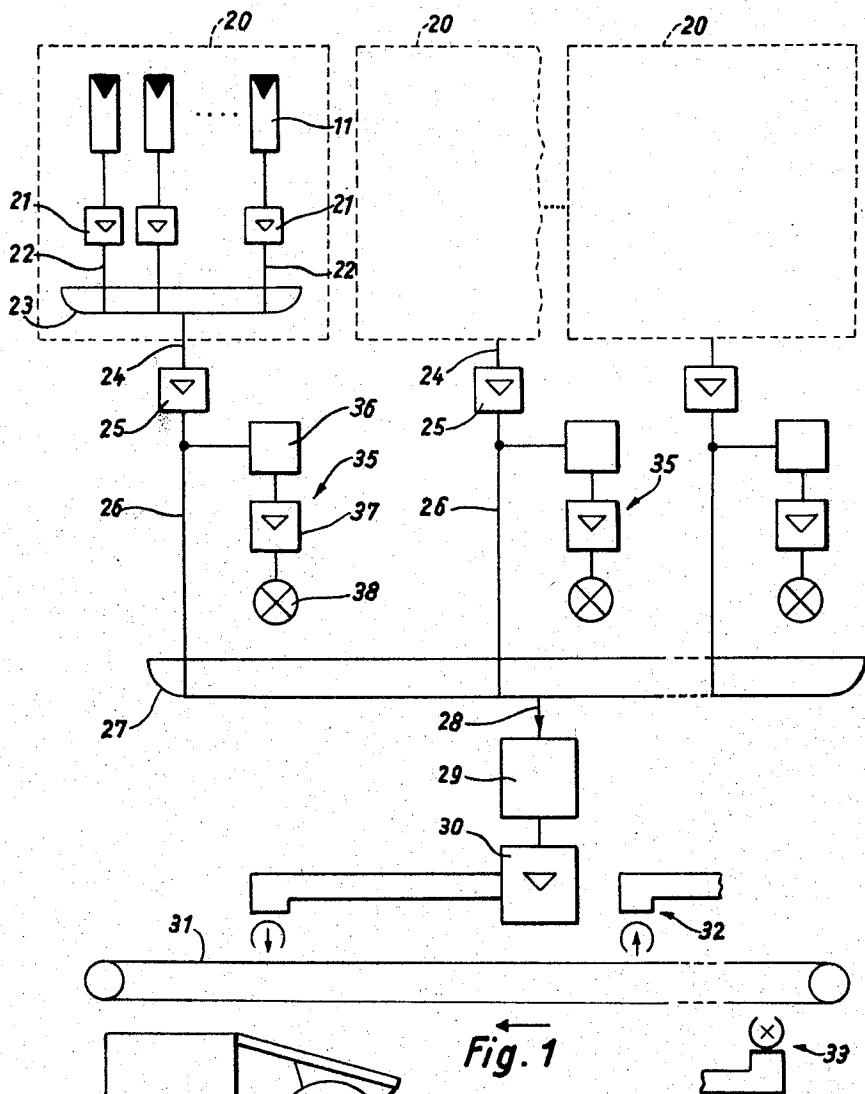
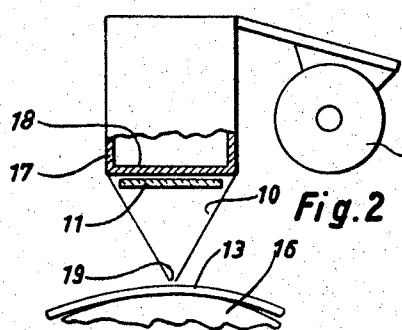
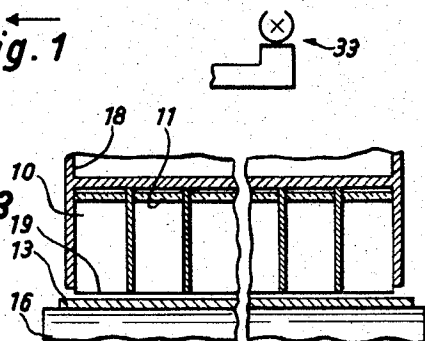


Fig. 1

Fig. 2

Fig. 3



INVENTOR

Helmut Schäfer

BY *Harness, Dickey & Pierce*  
ATTORNEYS

1

3,454,160

## ARRANGEMENTS FOR SORTING IMPERFECT SHEETS OF MATERIAL FROM A WEB OF MATERIAL

Helmut Schäfer, Kernerstrasse 5, Neuffen, Württemberg, Germany

Filed Mar. 24, 1967, Ser. No. 637,050

Claims priority, application Germany, Mar. 26, 1966, B 86,378

Int. Cl. B07c 5/34

U.S. Cl. 209—111.7

7 Claims

### ABSTRACT OF THE DISCLOSURE

The present invention discloses an arrangement for sorting imperfect sheets of material from a moving web of material, particularly a web of paper; the construction of the invention allowing a large number of sensors to be used either individually or in groups using OR-circuit linkages connected in parallel without the groups damping each other.

#### Background of invention

In a known arrangement of this kind, the web of material is fully sensed for imperfections by stationary sensing arrangement. This sensing arrangement has a plurality of photo-cells sensing adjacent sectors of the web, the output signals of which photo-cells are converted by a signal evaluating arrangement into fault signals indicating the positions of imperfections. The fault signals are then superimposed on a control device for controlling the sorting of the imperfect sheets discovered. This known arrangement has a relatively small number of photo-cells distributed across the width of the web, in order to maintain the technical resources within admissible limits. However, in this arrangement, only a relatively small number of faults is detected. In order to obtain a high rate of fault detection, it is necessary for the separate sensors to sense only a relatively small area of the web. However, with the conventional web widths, this requires the use of a great number of sensors.

#### Summary of the invention

According to the present invention an improved arrangement for sorting imperfect sheets of material from a moving web of material, particularly a web of paper, in which arrangement the web of material may be fully sensed for imperfections by a stationary sensing device having a plurality of photo-sensitive sensors adapted to sense adjacent sectors of the web; a signal evaluating device converts the said sensor signals into fault signals indicating the positions of imperfections, which fault signals may be superimposed on to a control device for controlling the sorting of the imperfect sheets indicated, wherein the improvement comprises the sensors, each provided with a pre-amplifier, being divided into a plurality of sensor groups, a group OR-circuit for each group for combining the output signals of the associated pre-amplifiers, a terminal OR-circuit responsive to output signals of these group OR-circuits and means for applying to the control device for controlling the sorting of imperfect sheets of material a signal derived from the terminal OR-circuit.

The construction of the invention enables a large number of sensor groups in OR-linkage to be connected in parallel, without the groups damping each other. For this purpose, diodes may be provided in the separate signal leads leading to the OR-circuits. The power amplification stage combines the output signals from the terminal OR-circuits and gives out a defined output signal of specific amplitude.

2

The arrangement in accordance with the invention is advantageous in that that a very large number of sensors may be used. It is particularly advantageous for the sensors to be constructed as photo-elements, particularly silicon photo-elements. A fault detection system suitable for sorting imperfect sheets of paper is generally obtained if the web sensing width associated with one sensor is a few millimetres, preferably 5–20 mm., particularly about 10 mm. Example: Two hundred sensors are required for fully sensing a web width of 200 cm. when the sensing width is 10 mm.

As stated, the sensors are combined in groups. It is advantageous if the number of sensors in each group is relatively small, about ten sensors per group, for example.

The sorting arrangement of the invention is also particularly advantageous in that it may be used up to the greatest web speeds, since its detection capacity with respect to time is limited virtually only by the time constant of the sensors. However, sensors of sufficiently low time constant are available. For example, silicon photo-elements may be used advantageously as sensors, as already mentioned.

#### Brief description of the drawings

An embodiment of the invention will now be further described by way of example with reference to the accompanying drawings in which:

FIG. 1 is a circuit diagram of a sorting arrangement in accordance with an embodiment of the invention,

FIG. 2 is a side view, partly in section, of a sensor device for sensing imperfections in material webs,

FIG. 3 is a front elevation, in longitudinal section, of a portion of the sensor device illustrated in FIG. 2.

#### Description of the preferred embodiment

In the drawings, corresponding parts carry the same reference numerals.

The sensing device in FIGS. 2 and 3 has a plurality of silicon photo-elements 11 arranged in separate sensor compartments 10. The light reflected from the surface of the web of material 13 falls on the said photo-elements. The web of material is illuminated by the strip light 14 and conducted over a guide roller 16 provided with a black surface 15.

The sensor housing 17 also has, apart from the compartments 10, compartments 18 for accommodating circuit components, and extends (in a manner not illustrated in detail) across the entire width of the web of material. Thus, the separate light admission gaps 19 extend in the form of a linear over-all gap across the entire width of the web of material, so that the latter is fully sensed. In order to obtain a high rate of detection of imperfections, the width of the gap is extremely small, preferably about 0.3–1.0 mm. The length of the gaps in the separate sensor compartments corresponds virtually to the width of the sensor compartments and, as previously mentioned, is advantageously 5–20 mm., preferably about 10 mm. Preferably, the distance of the light admission gap 19 from the web 13 may be about 1–3 mm.

In order to obtain the accurate coverage of each separate sensor and thus the accurate sorting of faulty sheets of material, despite the large number of sensor compartments, and to justify the attendant technical resources involved, the photo-sensitive sensors are combined into a plurality of sensor groups 20, as illustrated in FIG. 1. Preferably, each sensor group comprises five to fifteen, particularly ten, sensors. A pre-amplifier 21 is connected on the output side of each sensor, the pre-amplifier being constructed so that it not only amplifies but also trims the separate sensor signals, so that merely those sensor signal peaks corresponding to a faulty part of the web of

material appear on the output leads 22 of the individual preamplifiers 21. In the embodiment, these are dark signals corresponding to the dark places on the web of material. As a consequence of the dark background of the guide roller 16, tears or holes in the web 13 of material also produce dark signals.

Further, the pre-amplifier is constructed so that when different working points are occasioned by fluctuations in the background brightness of the sensed web of material, approximately uniform signal amplitudes also appear on the lead 22 at uniform brightness fluctuations. Since the construction of the pre-amplifiers, having the characteristics described, is known to the expert, it is not illustrated in detail.

The fault signals appearing on the leads 22 of a group 20 are superimposed on to a group OR-circuit 23 whose output signal is fed to a terminal amplifier 25 via a lead 24. A terminal amplifier 25 of this kind is associated with each group 20. The output signals of the terminal amplifiers appearing on the leads 26 are superimposed on to a common OR-circuit 27 on whose output lead 28 appears a fault signal indicating each flaw in the web of material. This fault signal passes through a pulse shaper stage 29, is power-amplified in a power amplifier 30, and subsequently stored on an endless magnetic tape 31 rotating at the speed of the web. After covering a pre-determined distance corresponding to the distance covered by an imperfect sheet of material until it reaches the sorting position, the stored signal is picked up by the pick-up head 32 and fed as a control signal to the control arrangement for picking out the relevant faulty sheet. The erase head for erasing the fault signal is designated 33.

In order to facilitate the adjusting of the sensitivity of the sorting arrangement of the invention, an individual optical fault indicating arrangement 35 is associated with each sensor group 20 and comprises a pulse shaper stage 36 having an amplifier 37 and an indicator lamp 38 connected on the output side.

I claim:

1. An improved mechanism for sorting imperfect sheets of material from a moving web of material such as a web of paper, said mechanism comprising a plurality of photo-sensitive sensing means fixed relative to the moving web, said photo-sensitive sensing means being positioned adjacent to each other for sensing adjacent sectors of the web, a plurality of pre-amplifiers, each pre-amplifier being in circuit with a respective one of said photo-sensitive sensing devices for amplifying the signal therefrom, a

plurality of OR circuits, the number of such OR circuits being less than the number of said photo-sensitive sensing means and pre-amplifiers, means for conducting the output signal of each of a group of said pre-amplifiers to a respective one of said OR circuits, a terminal OR circuit, means for conducting the output signal of each of said first mentioned OR circuits to said terminal OR circuit, and means for applying the output of said terminal OR circuit to a control means for controlling the sorting of imperfect sheets of material from the moving web in response to a signal derived from said terminal OR circuit.

2. An arrangement according to claim 1 in which a terminal amplifier is responsive to signals from the terminal OR-circuit and said last mentioned means is responsive to a signal from the terminal amplifier.

3. An arrangement according to claim 1 in which a terminal amplifier provides an output signal in response to a signal from the terminal OR-circuit, which output signal is applied to said last mentioned means through a pulse shaping stage.

4. An arrangement according to claim 1, in which the photo-sensitive means is comprised as silicon photo-elements.

5. A mechanism according to claim 1 wherein the pre-amplifiers include means for removing peaks transmitted thereto by said photo-sensitive sensing means in response to bright areas on the web of material.

6. An arrangement according to claim 1, wherein an indicating device for indicating fault signals is associated with each of the first mentioned OR-circuits.

7. An arrangement according to claim 1 wherein the number of pre-amplifiers and photo-sensitive sensing means connected to each of said OR circuits is in the range of about 5 to 15.

#### References Cited

##### UNITED STATES PATENTS

|           |        |           |           |
|-----------|--------|-----------|-----------|
| 2,758,712 | 8/1956 | Linderman | 209—111.7 |
| 2,939,963 | 6/1960 | Rideout   | 250—219   |
| 3,206,606 | 9/1965 | Burgo     | 250—219   |

ALLEN N. KNOWLES, *Primary Examiner*.

RICHARD A. SCHACHER, *Assistant Examiner*.

U.S. Cl. X.R.

83—365; 250—219