United States Patent

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[73] Assignee **Honeywell Information Systems Inc.**

[54] **OVERLAPPED DOCUMENT DETECTOR**
10 Claims, 4 Drawing Figs.

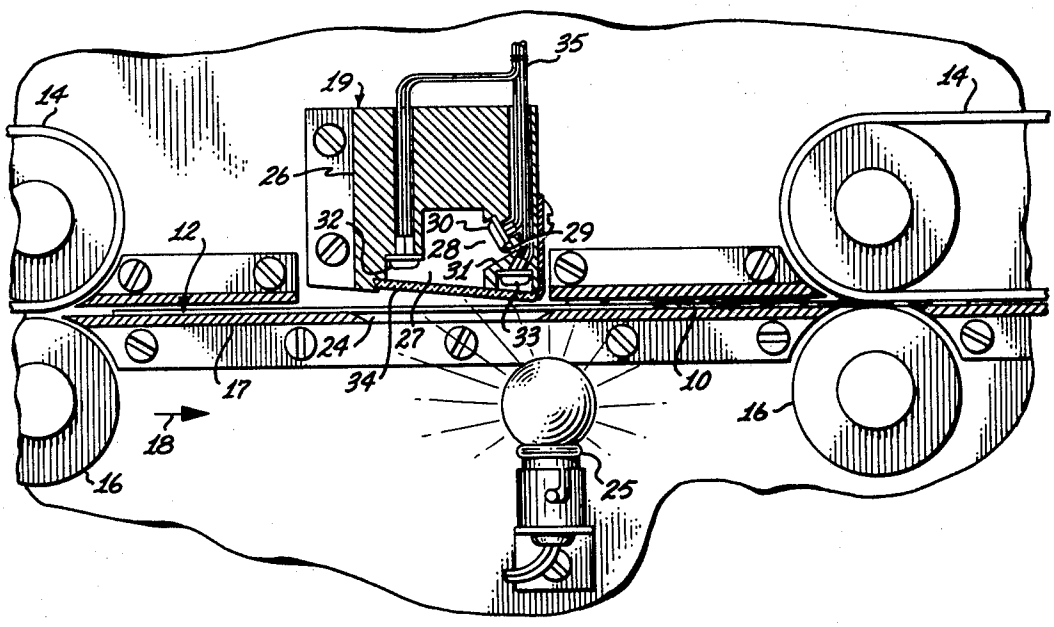
[52] **U.S. Cl.** **271/47,** 271/57, 250/119
[51] **Int. Cl.** **B65h 7/12**
[50] **Field of Search** ..... 271/47, 57; 209/117.7; 250/219 (I) (dc), 223

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ABSTRACT: A document handling system is disclosed in which the documents are serially-fed along a predetermined path. The system further includes a sensor apparatus to detect any overlapped feeding of the documents.



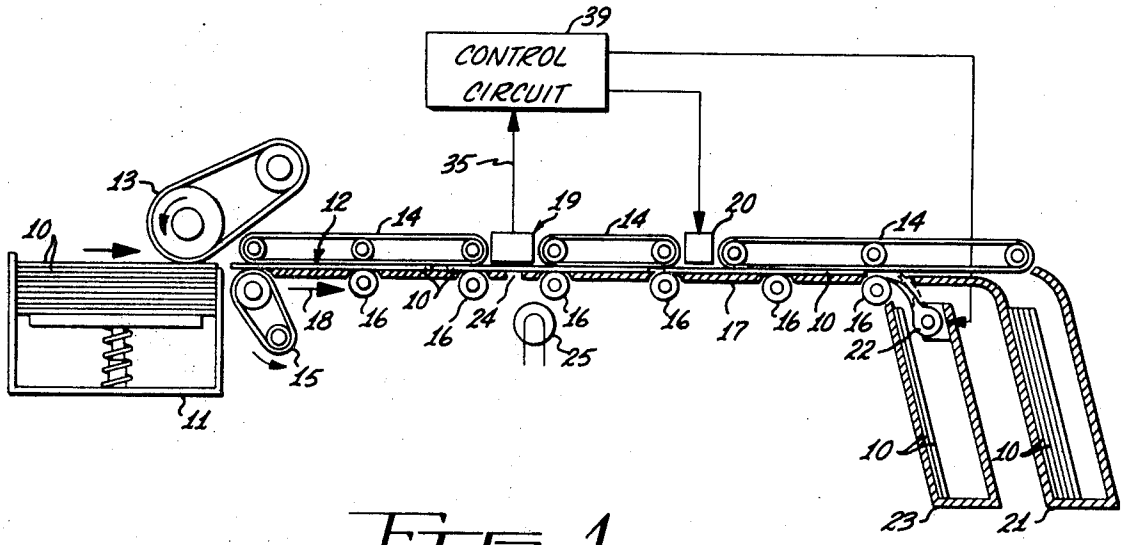


Fig. 1

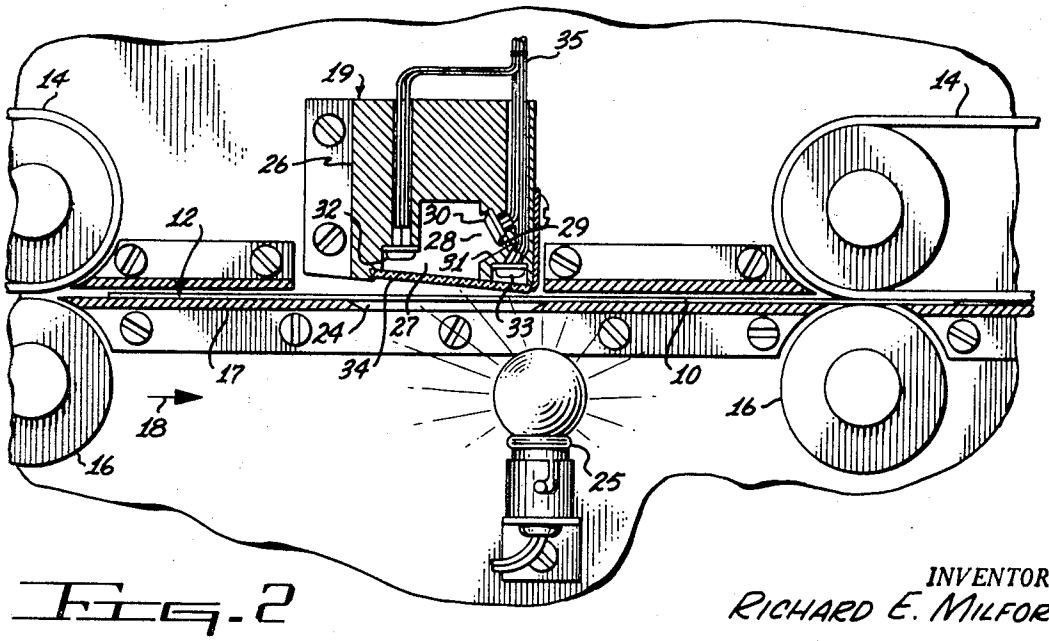


Fig. 2

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2 Sheets-Sheet 2

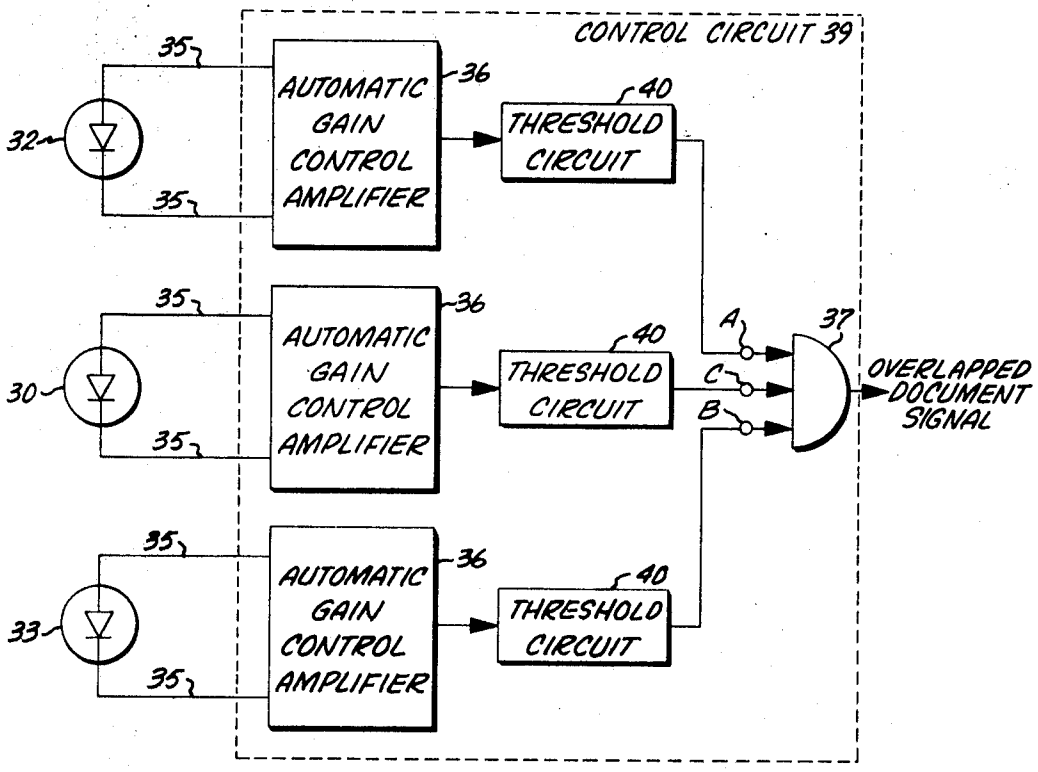


Fig. 3

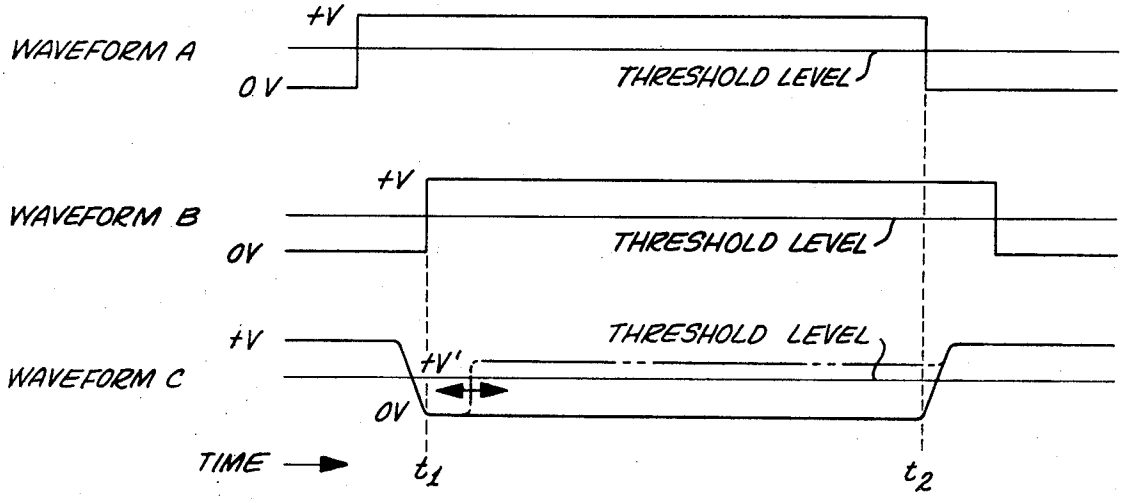


Fig. 4

OVERLAPPED DOCUMENT DETECTOR

BACKGROUND OF THE INVENTION

This invention relates generally to an apparatus for the detection of the condition of overlapped documents as they are fed from a document supply to a work station along a predetermined path and more particularly to a system employing a photosensitive device for detecting overlapped documents in serial-fed document handling equipment.

1. FIELD OF THE INVENTION

In high speed data processing systems, information processed by the system is normally supplied from an external source. One such external source in common usage today is so-called data handling equipment which furnishes information to the data processing system from a variety of generally translucent information bearing media such as bank checks, deposit slips, bills, stubs, and specially designed forms.

Document handling equipment of this nature normally includes an input hopper containing a supply of documents from which individual documents are transported in serial fashion along a document path to a work station. This work station will perform a function such as reading the information contained on the document after which the documents are transported to other work stations or directly to an output hopper depending on the particular document handling function required.

The serial feeding as hereinbefore described results in gaps between the successively transported documents. These gaps are important in that they permit the document handling equipment to identify the work station output as a series of individual records rather than a continuous stream of information. The gaps also allow sufficient time for any mechanical functions to transpire such as deflection into the reject hopper. Occasionally documents are improperly fed in a partial or complete overlapped condition resulting in errors, such as partial or complete loss of information on the overlapped documents.

2. DESCRIPTION OF THE PRIOR ART

To prevent work station errors which may result from an overlapped condition of documents being transported within document handling equipment, some means must be provided for detecting this condition so that corrective measures may be taken. In the customary apparatus, the detection of an overlapped document condition is accomplished by a sensing apparatus which produces a signal upon detecting the presence of overlapped documents. This signal is employed to inactivate the work station during the passage of the overlapped documents and directs them to a reject hopper. The rejected documents may then be removed from the reject hopper for subsequent reprocessing.

In the prior art, several systems have been provided for detecting overlapped documents in document handling equipment. One such system employs a photosensitive device and a light source disposed on opposite sides of a document path. Light rays emanating from the light source will cross the document path and impinge on the photosensitive device. The intensity of the impinging light rays varies from full value with no document between the light source and the photosensitive device, to an attenuated value for a single document arranged between the light source and the photosensitive device, to a further attenuated value for overlapped documents. The photosensitive device will sense the light rays and produce signals representative of the amount of light impinging on its photosensitive surface. The signals produced by the photosensitive device are coupled to an amplifier that is adjusted to deliver an overlapped document signal upon sensing the second attenuated value.

This type of device is not satisfactory because the photosensitive device is subjected to large variations in the amount of impinging light which relegates the differential between first and second attenuated values to a relatively small portion of the photosensitive device's operating range. Thus, the difference between the light attenuated by a single thin document and that attenuated by overlapped thin documents is often insufficient to be satisfactorily detected by the photosensitive device.

Another prior art device utilizing the previously described principles further includes an air supply for separating the overlapped documents. The separation of the overlapped documents results in an increase in the differential between the attenuated values of a single thin document and overlapped thin documents to a point where the difference can be detected. This prior art device is also not completely satisfactory due to its inability to separate documents that are stapled, taped or otherwise stuck together.

Systems of the type just described generate signals representative of the conditions sensed as hereinbefore described. To insure proper detection of overlapped documents, the levels of these signals must not be allowed to vary outside of predetermined limits. To compensate for signal level variations which would result if a batch of documents being processed differed from a preceding batch in such factors as document thickness, paper density, etc., it is customary in the art to provide for manual adjustment of the gain of the signal amplifiers. Therefore, a need exists for a self-adjusting system that will maintain the output signal levels within predetermined limits.

SUMMARY OF THE INVENTION

To alleviate the problems of the prior art, the document sensing system of the present invention utilizes a photosensitive device positioned to respond to only that light which is diffused by its passage through a document to produce a signal representative of overlapped documents. The signal thus produced may be coupled to an automatic control circuit for delivery to other components within the document handling equipment.

It is, therefore, one object of this invention to provide an improved system for detecting overlapped translucent items.

Another object is to provide an improved system for detecting thin overlapped documents.

A further object of this invention is to provide an improved system for detecting overlapped documents when the documents are physically united.

A still further object is the provision of an overlapped document detector system which automatically adjusts for signal level variances between successively processed batches of documents.

The foregoing and other objects of this invention, the various features thereof as well as the invention itself, may be more fully understood from the following description when read together with the accompanying drawings, in which:

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** is a diagrammatic view showing a document handling device incorporating the present invention;

FIG. **2** is an enlarged plan view of a portion of the document handling device, partially in section, illustrating the features of the invention;

FIG. **3** is a block diagram of the logic circuitry of the invention; and

FIG. **4** is a timing chart illustrating the relationship between the signals occurring in the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

This invention is described as being employed in document handling equipment, but may be used in other types of equipment handling translucent or semitranslucent material such as packaging machines, conveyor devices and the like.

Referring more particularly to the drawings by characters of reference, FIG. **1** illustrates schematically a document handling device wherein documents **10** stacked in an input hopper **11** are fed along a document path **12**. A picker belt **13** is positioned to engage the top document in the input hopper and effect its movement into position between the first of a series of

feed belts 14 and a counter rotating restraining belt 15. The feed belts 14 advance the documents along the document path while the restraining belt 15 reduces the possibility of feeding more than one document at a time. In some instances, however, more than one document will be fed along this path at one time, thereby creating an overlapped condition. The document path 12 is defined by the feed belts 14 positioned on one side of the path of movement of the documents and on the opposite side of this path by a plurality of rollers 16 spacedly arranged along a bedplate 17. The documents being conveyed along the document path 12, in the direction indicated by arrow 18, will pass an overlapped document sensor 19 and then advance through a work station 20 to an output hopper 21. When an overlapped document condition occurs, a signal will be generated by sensor 19 and a control circuit 39 which temporarily inactivates the work station 20 and energizes a gate 22 which directs the overlapped documents into a reject hopper 23. Sensor 19 responds to directly radiated light and diffused light in its operation. Directly radiated light is that light which travels in a straight line from a light source, and diffused light is that light which is scattered by its passage through an object. Sensor 19 employs well-known light sensitive elements such as silicon photocells having photovoltaic properties. For purposes of this embodiment, the photocells illustrated produce electrical signals proportional to the amount of light impinging on their sensitive surfaces. Such devices are illustrated and described in Millman, "Vacuum Tube and Semiconductor Electronics," published by McGraw-Hill, 1958, pp. 152 through 154.

The overlapped document sensor 19, best seen in FIG. 2, is positioned adjacent to the document path 12 and is aligned with an aperture 24 in bedplate 17. Aperture 24 provides an opening for radiated light from a light source 25 to cross the document path 12 to impinge upon sensor 19.

Sensor 19 comprises a housing 26 which defines cavity 27 having a recess 28 arranged within the cavity. Recess 28 is defined by a bottom surface 29 and a sidewall 31. A photocell 30 is affixed to surface 29 and is shielded from directly radiated light by sidewall 31. Cavity 27 is designed so that directly radiated light is partially absorbed by low reflection qualities of its walls. The direct reflection that does take place is directed away from the photocell 30. Diffuse reflection in the cavity is minimal and will not affect the operation of the photocell 30. The design of the cavity 27 and the positioning of the photocell 30 within the recess 28 results in the photocell responding only to light which is diffused by its passage through a single document or through overlapped documents. A second photocell 32 is mounted in housing 26 upstream from cell 30 relative to document flow along path 12, and is responsive to directly radiated light from source 25 through aperture 24. A third photocell 33 is mounted within housing 26 downstream from cells 30 and 32 and is also responsive to directly radiated light from source 25 through aperture 24. Housing 26 is further provided with a transparent window pane 34 closing cavity 27 which prevents dust and foreign material from collecting on the cells, thereby decreasing their sensitivity.

Cells 32 and 33 are employed to detect the presence of a document in path 12 between sensor 19 and light source 25. The absence of a document in path 12 and across aperture 24 causes directly radiated light to impinge on cells 32 and 33, causing these cells to reach a maximum condition, thereby generating a relatively high signal. With a document present in path 12 across aperture 24, the intensity of the radiated light is attenuated, thereby causing cells 32 and 33 to generate a relatively lower signal.

Cell 30 is positioned to detect an overlapped document condition and produces a signal indicative thereof. Light diffused by its passage through a single document will impinge on cell 30 and cause it to generate a relatively high signal while light diffused by overlapped documents reduces approximately 50 percent the value of this generated signal. With no document present in path 12 over aperture 24, cell 30 generates little signal.

The signal produced by cell 30 is proportional to the amount of light impinging on its light sensitive surface as hereinbefore described, hence a thin document will affect the generation of a relatively larger signal than a thick document. To prevent these variations from resulting in erroneous signals, the output leads 35 of cell 30 are coupled to an automatic gain control AGC amplifier 36 of control circuit 39 which automatically regulates the high signal produced by the cell to a predetermined level. Identical automatic gain control amplifiers 36 are also coupled to the output leads 35 of cells 32 and 33 to automatically regulate the signals produced by these cells which may vary with light source intensity variations and the like. An AGC amplifier suitable for use in this environment is disclosed in my copending U.S. Pat. application filed on Aug. 9, 1968, Ser. No. 751,581, entitled "Automatic Gain Control Circuit for Photocell Amplifiers," assigned to the assignee of this invention. However, it is not intended that the use of this invention be restricted for use in conjunction with a particular amplifier.

The gain of amplifier 36 slowly increases after the passage of the last document in a batch, and quickly and automatically adjusts to a level commensurate with the first document of a new batch, thereby providing automatic regulation of signal values which may vary between batches of documents. The simplified logic diagram illustrated in FIG. 3 discloses the output signals of cells 30, 32 and 33 coupled to amplifier 36, which regulates and couples representative output signals through threshold circuits 40 to AND gate 37. The threshold circuits 40 may be the well-known Schmitt trigger circuit which produces an output voltage of a given level in response to input voltages which exceed a predetermined threshold level. The circuits 40 are employed to prevent erroneous signals from being generated by minor voltage changes that may be caused by dark spots on a document, slight variations of document thickness within a batch, perforated documents and the like.

AND gate 37 performs the logical function of conjunction and will produce an overlapped document output signal when, and only when, all the signals applied thereto are at a given level. By proper design, as explained in the copending application, the AGC amplifiers 36 can provide output signals varying from a reference or zero potential with maximum light intensity on the cells to an output signal of $\pm V$ with minimum light intensity on the cells.

The sequence and timing of the signals applied to AND gate 37 are shown by waveforms A, B, and C in FIG. 4. The output of cells 32 and 33 (waveforms A and B) are biased to a low voltage reference level when the signal produced by the cells is at a regulated maximum, and will be considered at a higher voltage level when the signal produced by the cells decreases. As seen in FIG. 4, the output signals of cells 32 and 33 (waveforms A and B) will go from a low voltage level (no document present) to a high voltage level (document present), thus transmitting two of the necessary signals for conjunction in AND gate 37 to its terminals A and B. The output signal of cell 30, (represented by waveform C), is biased to a high voltage level $+V$ when no document is present, and will go to a low voltage level OV when it receives the light diffused by a single document, and rises to an intermediate voltage level $+V'$ when it receives light diffused by its passage through overlapped documents. AND gate 37 will produce an output signal only when the input signal from cell 30 is at an intermediate level and cells 32 and 33 are at their highest voltage level. The portion of waveform C that is shown in dashed lines indicates the signal produced by cell 30 upon the occurrence of overlapped documents. The leading edge of this latter portion of the signal indicates the time at which the overlapping of the documents occurs.

The level changes of waveforms A and B occur at different times, as seen in FIG. 4, due to the physical positioning of cells 32 and 33 as hereinbefore described. This time differential permits the detector system to generate an overlapped document signal between the times indicated by t_1 and t_2, thus rendering the system incapable of producing an overlapped

document signal during the entry and exit of a document from the path between the sensor and the light source. If the detector system was operative during the gaps between successively transported documents, cell **30** would change from low voltage level signal (single document) to a high voltage level signal (no document) and during the transition would produce an intermediate signal indicative of overlapped documents.

While the principles of the invention have now been made clear in a preferred embodiment, there will be immediately obvious to those skilled in the art many modifications of structure, arrangement, proportions, the elements, materials, and components used in the practice of the invention, and otherwise which are particularly adapted for specific environments and operating requirements without departing from these principles. The appended claims therefore intend to cover and embrace any such modifications within the limits only of the true spirit and scope of the invention.

I claim:

1. An apparatus for detecting overlapped documents transported along a document path comprising: a light source positioned adjacent to one side of the document path; a light sensitive element disposed on the other side of the document path substantially opposite to said light source; and means for shielding said light sensitive element from directly radiated light from said light source, so that said light sensitive element will detect only diffused light, said light sensitive element producing a first signal in response to diffused light transmitted through a single document and producing a second signal in response to diffused light transmitted through overlapped documents.

2. The apparatus as described in claim **1** wherein said means for shielding said light sensitive element from directly radiated light from said light source comprises a housing within which said light sensitive element is mounted, at least a part of said housing providing the shielding for said light sensitive element.

3. A system for detecting overlapped documents transported along a document path comprising: a light source positioned adjacent to one side of said document path; and a sensor disposed on the other side of said document path and substantially opposite to said light source, said sensor comprising a housing, said housing defining a cavity, and a light sensitive device disposed within said cavity, said light sensitive device being shielded within said cavity from directly radiated light and adapted to produce a first signal indicative of diffused light transmitted through a single document moving along said path past said light source and a second signal indicative of diffused light transmitted through overlapped documents moving along said path past said light source.

4. A system for detecting overlapped documents transported along a document path and controlling further movement of the documents when an overlapped condition occurs comprising: a light source positioned adjacent one side of the document path; a document sensor positioned adjacent the other side of the document path substantially in alignment with said light source, said sensor comprising a first detector means for detecting a document in the path between said sensor and said light source and for generating a first signal representative of the presence of the document, a second detector means for detecting overlapped documents in the path between said sensor and said light source, shielding means for shielding said second detector means from directly radiated light from said light source, said second detector means being responsive to diffused light transmitted through overlapped documents and producing a second signal in response thereto; and control means for controlling further movement of the documents along the document path in response to said first and second signals.

5. A system for detecting overlapped documents transported along a document path comprising: a light source positioned adjacent to one side of said document path; a document sensor positioned adjacent to the other side of said document path and substantially in alignment with said light source, said sensor comprising a housing, said housing defining a cavity, a first light sensitive element mounted within said cavity, said first light sensitive element being shielded from directly radiated light within said cavity, said first light sensitive element producing a first signal indicative of diffused light transmitted through a single document moving along said document path past said light source and a second signal indicative of diffused light transmitted through overlapped documents moving along said document path past said light source, second and third light sensitive elements mounted within said housing on opposite sides of said first light sensitive element, said second and third light sensitive elements each producing a signal representative of a document present in said path between said sensor and said light source; and means for transmitting an overlapped document signal upon the occurrence of the signals produced by said second and third light sensitive elements and the second signal produced by said first light sensitive element.

6. An overlapped document detector system as described in claim **5** wherein said means for transmitting an overlapped document signal comprises an AND gate, the input signals of which are the signals produced by each of said first, second and third light sensitive elements.

7. A system for detecting overlapped documents transported along a document path comprising: a light source positioned adjacent one side of said document path; a housing positioned adjacent the other side of said document path and in alignment with said light source; a sensor comprising a first light sensitive element mounted within said housing so as to be shielded from directly radiated light from said light source, said first light sensitive element adapted to produce a first signal indicative of diffused light transmitted through a single document and a second signal indicative of diffused light transmitted through overlapped documents; second and third light sensitive elements mounted within said housing adjacent said path on opposite sides of said first light sensitive element, said second and third light sensitive elements each producing a signal in response to the presence of a document in said path between said light source and said sensor; means for automatically adjusting the signals produced by said first, second and third light sensitive elements to compensate for signal variances between successively transported batches of documents; and an AND gate coupled to receive the output signals of said light sensitive elements, said AND gate transmitting an output signal upon the occurrence of the signals generated by said second and said third light sensitive elements and said second signal generated by said first light sensitive element.

8. An apparatus for detecting overlapped documents transported along a document path comprising: a light source positioned adjacent one side of the document path; a light sensitive element disposed on the other side of the document path and substantially opposite to said light source; means for shielding said light sensitive element from directly radiated light from said light source, so that said light sensitive element will receive only diffused light, said light sensitive element producing a first signal in response to diffused light transmitted through a single document and producing a second signal in response to diffused light transmitted through overlapped documents; and means for controlling the sensitivity of said light sensitive element to compensate for signal variances between successively transported batches of documents.

9. A system for detecting overlapped documents transported along a document path comprising: a light source positioned adjacent one side of said document path; a sensor disposed on the other side of said document path and substantially opposite to said light source, said sensor comprising a housing, said housing defining a cavity, and a light sensitive device disposed within said cavity, said light sensitive device being shielded within said cavity from directly radiated light and adapted to produce a first signal indicative of diffused light transmitted through a single document moving along said path past said light source and a second signal indicative of diffused light transmitted through overlapped documents

moving along said path past said light source; and means for automatically adjusting the level of said first and second signals to compensate for signal variances between successively transported batches of documents.

10. A system for detecting overlapped documents transported along a document path comprising: a light source positioned adjacent one side of said document path; a document sensor positioned adjacent the other side of said document path and substantially in alignment with said light source, said sensor comprising a housing, said housing defining a cavity, a light sensitive element mounted within said cavity, said light sensitive element being shielded from directly radiated light within said cavity, said light sensitive element producing a first signal indicative of diffused light transmitted through a single document moving along said document path past said light source and a second signal indicative of diffused light transmitted through overlapped documents moving along said document path past said light source; means for detecting the presence of a document in said path between said light source and said document sensor and for producing a third signal indicative thereof; and means for transmitting an overlapped document signal upon the occurrence of said second and third signals.