

[54] SONIC ARTICLE-SORTING SYSTEM

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340/224
[51] Int. Cl.B07c 5/344
[58] Field of Search209/111.5, 111.8, 111.9;
340/152, 153, 152 TR, 171, 224; 179/2

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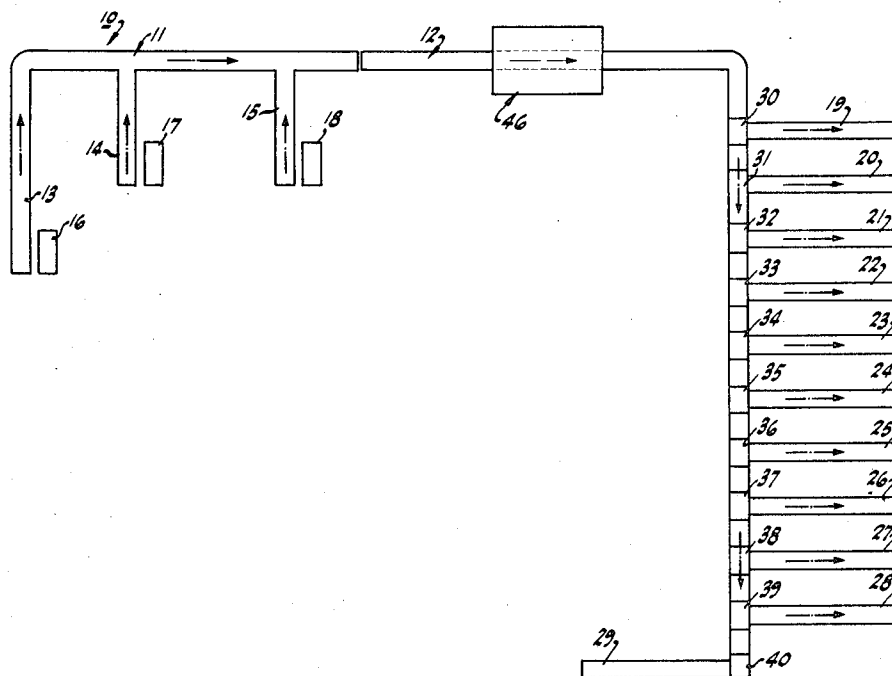
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[57] ABSTRACT

A sonic article-sorting system for processing passenger baggage at an airline terminal. A particular form of the system includes a conveyor having both a collection section along which baggage is accumulated and a distribution section providing a plurality of distribution branches or stations respectively corresponding to particular flight destinations and into which baggage is selectively diverted in accordance with the destinations thereof. A plurality of diverters disposed in respective association with the distribution branches are operative selectively to effect diversion thereinto of individual articles of baggage being advanced along the conveyor. Each article of baggage carries a tag equipped with an identification responder operative to transmit an ultrasonic signal corresponding to the destination indicated by the tag; and a plurality of interrogation units produce electromagnetic energizing signals adapted to intercept each article of baggage and the responder-equipped tag carried thereby. A plurality of sensors respectively connected with the diverters through control means are respectively responsive to the ultrasonic signals transmitted by the identification responders; and whenever a sensor responds to the ultrasonic signal of appropriate frequency resulting from the identification responder being intercepted by an energizing signal of proper frequency, the diverter associated with such sensor is actuated to segregate or divert into the appropriate branch the article of baggage carrying such transmitting responder.

17 Claims, 8 Drawing Figures



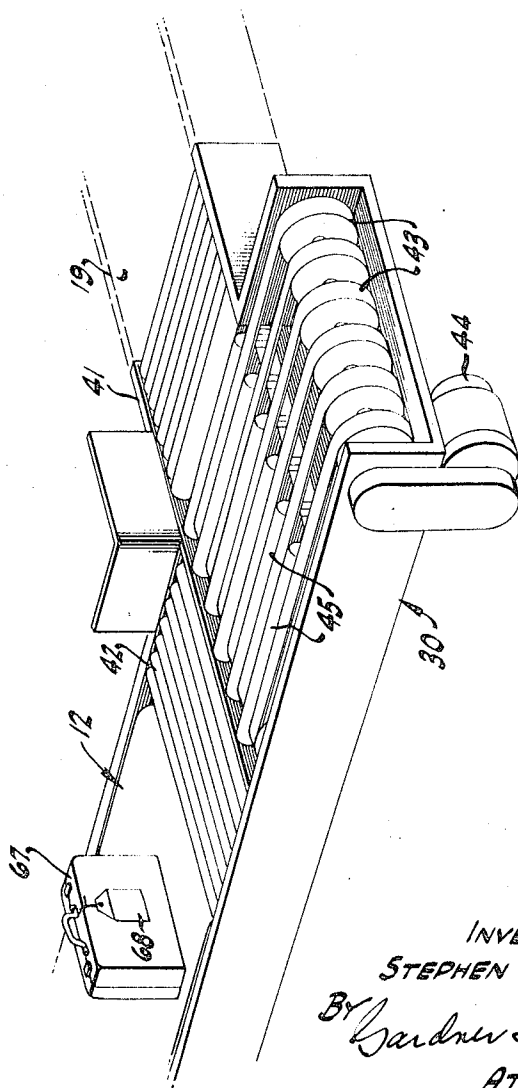
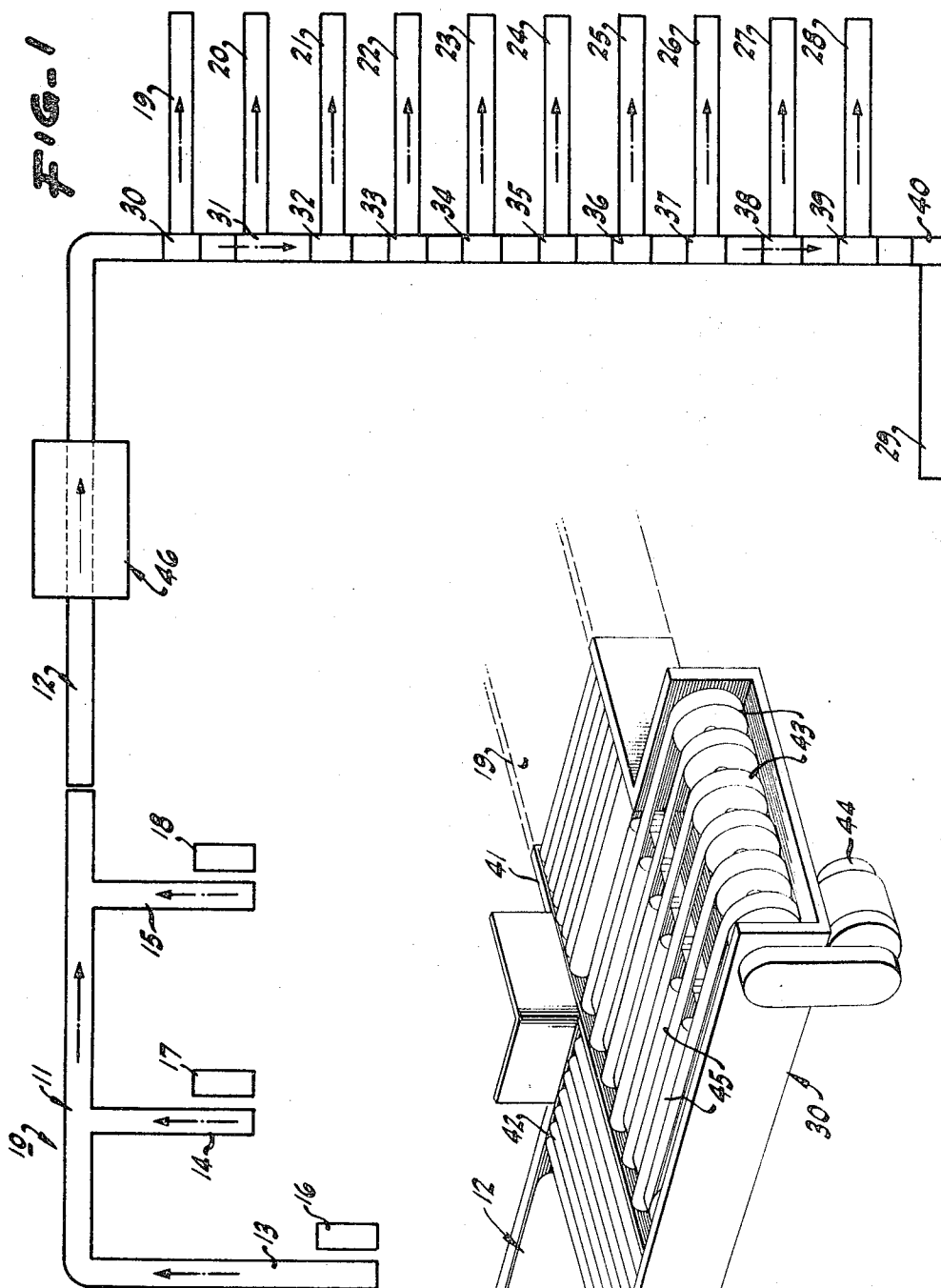


FIG. 2

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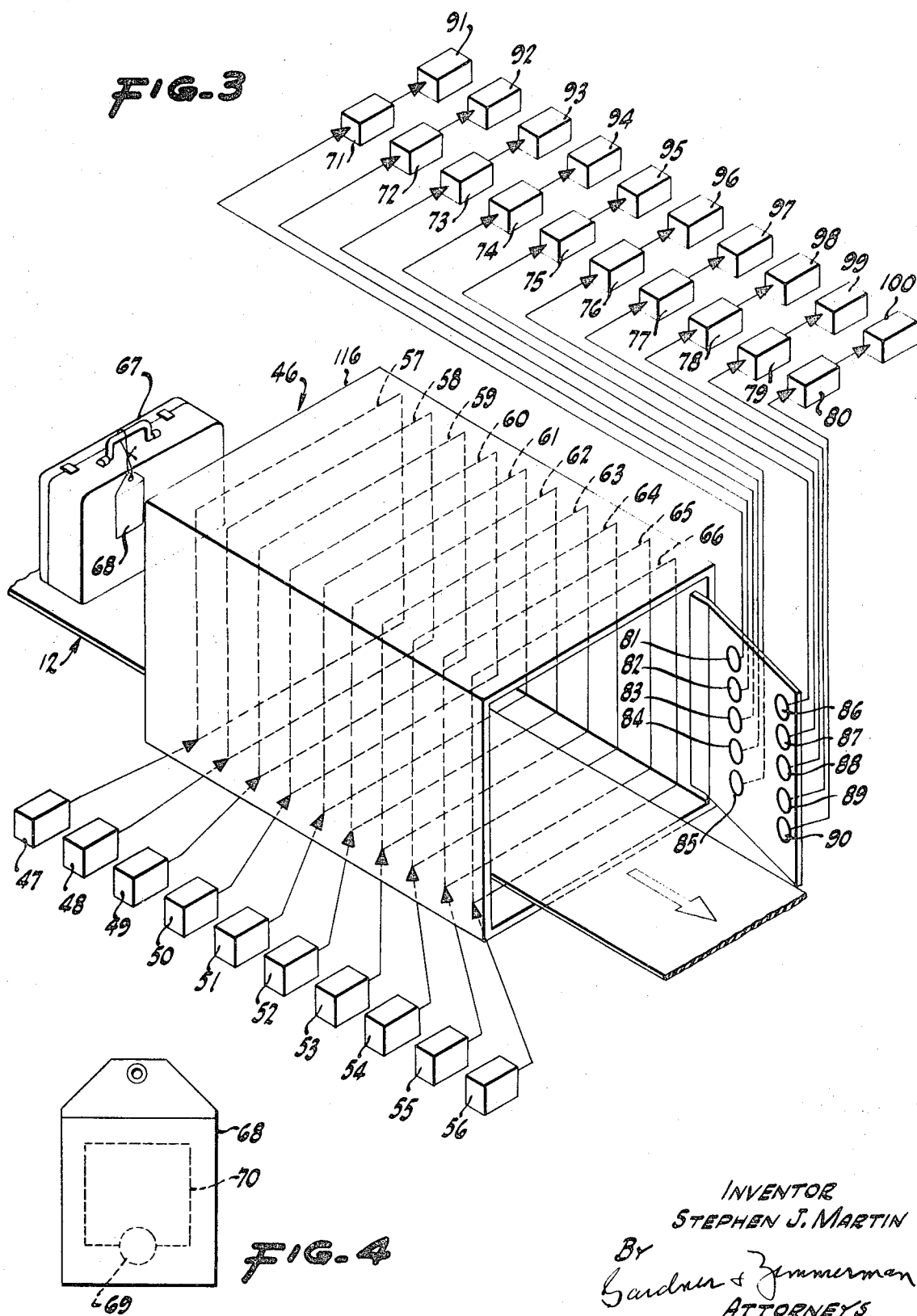


FIG. 5

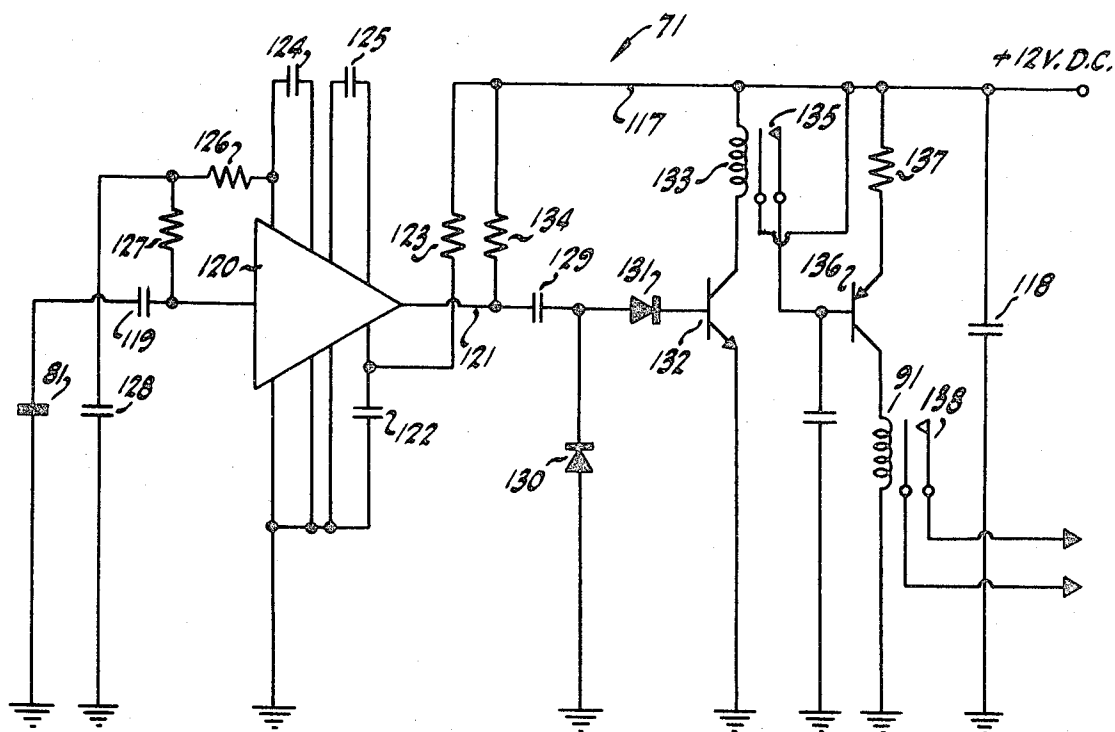
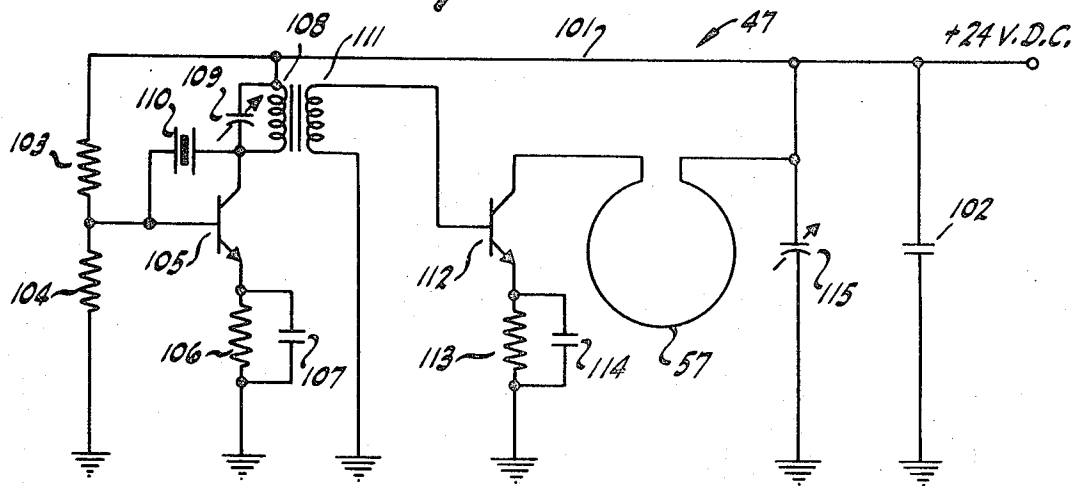
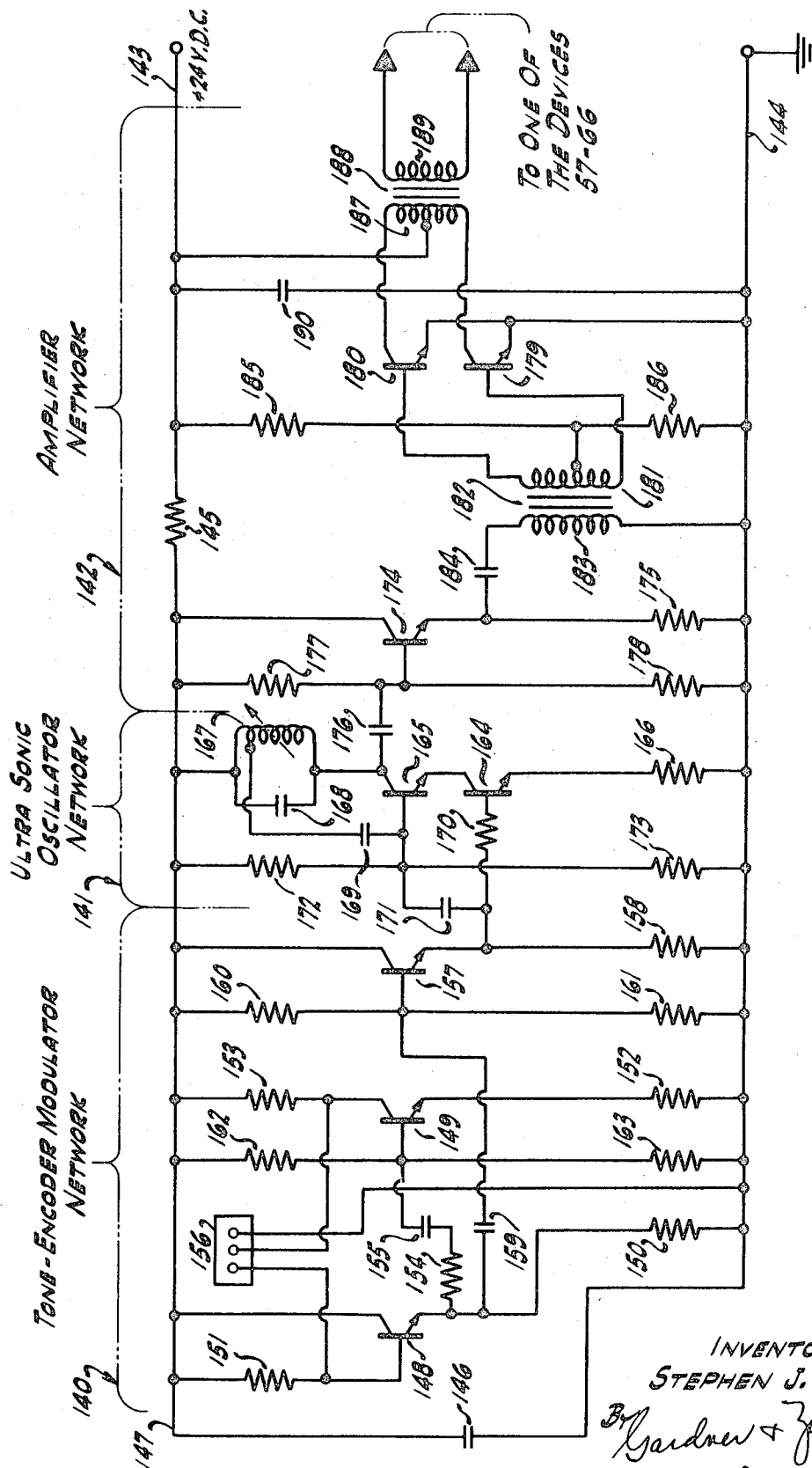


FIG. 6

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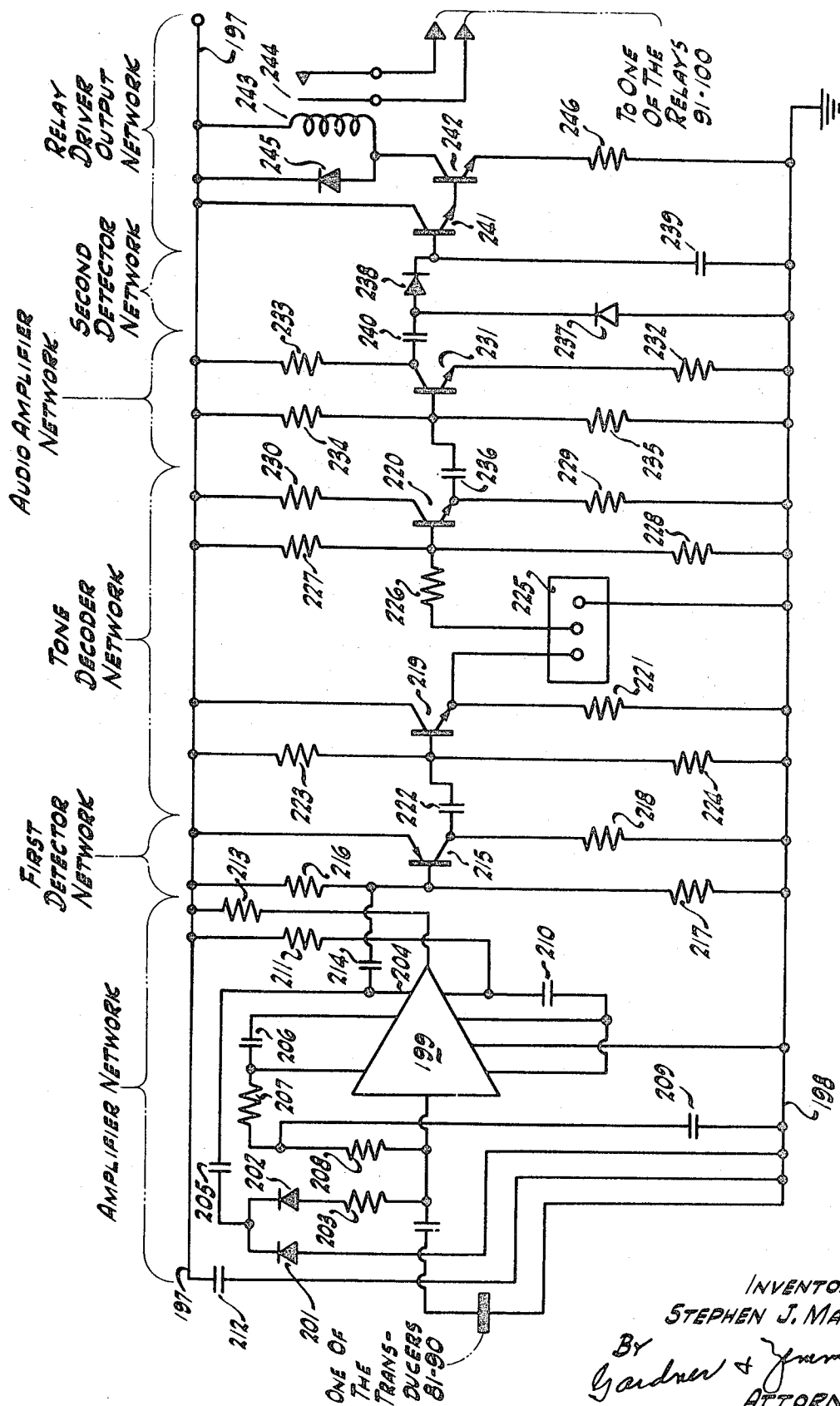


FIG. 8

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SONIC ARTICLE-SORTING SYSTEM

This invention relates to an article-sorting system in which intermingled articles are distributed in accordance with certain predetermined characteristics so as to collect or group those articles having like characteristics. The invention relates more particularly to a system of this type in which the articles themselves by means of self-identification determine and control such distribution and collection thereof. In even greater particularity, the invention relates to an ultrasonic sorting system having utility in a variety of environments — a specific example of which is baggage handling and especially the collection and distribution of baggage in airline terminals.

As explained in the copending patent application of John Charles Turner entitled "Baggage-Handling System", Ser. No. 728,521, filed May 13, 1968, now U.S. Pat. No. 3,520,406, the problems of tagging the baggage of departing passengers, collecting or accumulating the baggage from the various check-in counters, and then routing the baggage to stations from which it is finally placed aboard the proper planes to carry it to its destination are becoming more and more intense because of the increasing number of individual flights and the increasing number of passengers carried by each aircraft — several hundred passengers being anticipated for the newest jet planes. The same general problems pertain to distribution of the baggage of deplaning passengers, and the present complexities in this respect will be aggravated by the large masses of passengers deplaning from such newer planes.

The difficulties inherent in the processing of such baggage is more evident when it is appreciated that at present each piece of baggage is completely dormant or inactive, unable to cooperate in reaching its destination (as do airline passengers) except to carry a tag that must be manually inspected at each position along the baggage route at which a change in direction or other selection might be made in routing the baggage toward its destination. Any such change in direction also requires manual attention, and not only does all this requirement for manual attention prove costly, but error in misdirection due to human omissions and vagaries occurs at an increasing rate.

In view of the foregoing, it is evident that it would be advantageous to have an improved system for handling baggage at airline terminals, and especially a system in which each individual piece of baggage could take an active part in determining the routing therefor necessary to reach its proper destination without the requirement for human intervention; and it is, accordingly, an object of the present invention to provide such an improved system. Another object of the present invention is in the provision of an improved sonic article-sorting system in which intermingled articles, respectively equipped with self-identifying responders operative to transmit sonic energy at a frequency corresponding to certain predetermined characteristics of the articles, are distributed in accordance with such characteristics by means responsive to such sonic energy. Additional objects and advantages of the invention will become apparent hereinafter as the specification develops.

An article-handling system embodying the invention includes a conveyor having a collection section along which articles are accumulated in an intermingled manner unrelated to any group-determining characteristics thereof. The conveyor also has a distribution section providing a plurality of distribution branches or stations respectively corresponding to certain characteristics (flight destinations, for example) by which the articles are to be collected or grouped. A plurality of diverters disposed in respective association with the distribution branches are operative selectively to effect diversion into the branches of individual articles being advanced along the conveyor. Each such article is equipped with a self-identifying or identification responder responsive to an energizing signal produced by one of a plurality of interrogation units to transmit a sonic identification signal of particular frequency which is sensed by one of a plurality of sensors, and which one sensor actuates the diverter associated therewith to cause it to

segregate or divert into the appropriate distribution branch of the conveyor the article equipped with the transmitting responder.

Embodiments of the invention are illustrated in the accompanying drawings, in which:

FIG. 1 is a diagrammatic view of an article-handling system embodying the invention;

FIG. 2 is a broken perspective view illustrating one of the diverters of the system;

FIG. 3 is a diagrammatic perspective view depicting the article-identification system in association with a conveyor;

FIG. 4 is a face view in elevation of a typical transducer-equipped article-identifying tag;

FIG. 5 is a schematic circuit diagram of a particular embodiment of one of the interrogators;

FIG. 6 is a schematic circuit diagram of a particular embodiment of one of the sensors;

FIG. 7 is a schematic circuit diagram of a modified interrogator; and

FIG. 8 is a schematic circuit diagram of a modified sensor.

The particular article-handling system illustrated in FIG. 1 is intended for use at an airline terminal to process the baggage of departing passengers. The system includes a conveyor 10 comprising a collection section 11 and a distribution section 12. The collection section 11 has a plurality of supply branches 13, 14 and 15 feeding thereinto, and such branch conveyors may be located at quite divergent or separated positions throughout the terminal as, for example, the parking garage thereof, street entrance to the terminal, and each of the ticket counters therewithin. It will be appreciated that any convenient number of branch infeed or supply conveyors can be provided each leading either directly or indirectly to the main line of the collection section 11. As will be brought out more clearly hereinafter, each piece of baggage is tagged before being delivered to the collection section 11 of the conveyor, and tagging stations 16, 17 and 18 are shown in respective association with the branch infeed conveyors.

The distribution section 12 of the conveyor 10 has a plurality of distribution branches or stations located therealong respectively representative of particular characteristics by means of which the articles are to be distributed or grouped. In the case of the baggage-handling system illustrated, the distribution branches represent different flights or trip destinations for the baggage, and from such branches the pieces of baggage grouped or collected therealong will be placed upon proper aircraft for transport thereby to the appropriate destination. In the particular system shown, there are ten such distribution branches respectively denoted with the numerals 19 through 28; and a further branch or collection station at the end of the distribution section 12 is also provided so as to collect as a group baggage which has not been diverted into one of the branches 19 through 28.

A plurality of diverters are disposed along the distribution section 12 in respective association with the branches 19 through 28 so as to selectively divert articles of baggage thereinto. Accordingly, there are ten such diverters in the particular baggage-handling system illustrated, and they are respectively denoted with the numerals 30 through 39 and are associated with the branches 19 through 28, respectively. A continuously operative diverter or turn section 40 is provided in association with the branch 29 so as to divert thereinto all articles of baggage not diverted into one of the branches 19 through 28.

A typical diverter is illustrated in FIG. 2, and for purposes of specific identification may be taken to be the diverter 30. It should be noted, however, that each of the diverters 30 through 39 may be identical, and each may be completely conventional and may be any one of a number of selective transfers such as the Automatic Diverter Transfer sold by the Stewart-Galpat Corporation of Zanesville, Ohio. Accordingly, and as shown in FIG. 2, the diverter 30 has a somewhat T-shape with the stem 41 thereof communicating with the distribution branch 19 so as to deliver articles thereto and with

the cross bar 42 communicating at each end thereof with the main line of the distribution section 12. The cross bar comprises a plurality of spaced apart conveyor belts 43 continuously driven by a motor and drive train 44 so that the belts 43 travel from left to right along the upper stretches thereof, as viewed in FIG. 2.

Aligned with the stem 41 and defining the junction thereof with the cross bar 42 are a plurality of rollers 45 that are adapted to be positively driven and are alternately disposed between the spaced apart belts 43 and are selectively movable between a lower position in which they are positioned below the belts so as not to interfere with the articles of baggage being advanced thereby, and the elevated position illustrated in FIG. 2 in which they project above the belts 43 and are therefore operative to engage such article of baggage and divert the same from movement along the cross bar 42 and main line of the conveyor section 12 into the stem 41 of the diverter and onto the associated distribution branch 19. The diverter rollers 45 are selectively movable between the lower, retracted and upper, operative positions thereof by mechanism provided for this purpose which is responsive to external command such as provided by a control switch. Since the diverter 30 is conventional, no further details concerning its construction and operation appear necessary.

It may be observed that since there is no particular order to the manner in which baggage is fed to the collection section 11 of the conveyor and, therefore, no assurance of spacing between successive articles being advanced therealong, it is advantageous to provide some minimum spacing between successive articles along the distribution section 12 so as to afford sufficient time for the diverters 30 through 39 to either divert or pass one article and be reconditioned for interception of the next successive article advanced thereto. Such separation between successive articles may be provided by having the distribution section 12 operate at a higher linear velocity than that of the collection section 11; and by way of example, the collection section might have a linear velocity of the order of 100 feet per minute and the distribution section 12 a linear velocity of the order of 200 feet per minute. It will be apparent that the diverters are necessarily operative to accommodate articles at the rate or velocity at which they are advanced by the distribution section 12.

Associated with the conveyor along the distribution section 12 thereof is an article-identification system embodying the present invention and which in FIG. 1 is generally denoted with the numeral 46. Referring to FIG. 3 in particular, the system 46 includes an interrogator operative to produce an interrogation or energizing signal at a particular location along the distribution section 12 of the conveyor so as to be intercepted by the articles of baggage being advanced therealong. As will be explained hereinafter, the interrogator controls operation of the diverters 30 through 39 to cause the same to divert into the respectively associated branch conduits each article of baggage that responds in a predetermined manner to the interrogation signals produced by the interrogator. In the particular embodiment of the invention being considered, the interrogator comprises a plurality of individual interrogator units 47 through 56, respectively associated with the diverters 30 through 39 through sensors and control mechanism as described hereinafter.

Each of the interrogator units is operative to produce an energizing signal having predetermined characteristics that distinguish such signal from those produced by all of the other interrogators. The interrogator units and signals produced thereby may take a variety of forms and is conveniently of electromagnetic character. The purpose of the energizing or interrogating signal produced by each interrogator unit is to energize a passive and therefore normally dormant responder associated with an article of baggage being advanced along the distribution section 12 of the conveyor and which responder upon energization thereof effectively identifies the group-determining characteristics of the article of baggage so that it can be directed by the proper diverter into the proper collec-

tion station. A specific instance of an electromagnetic diverter is illustrated in FIG. 4 and will be described in detail hereinafter.

The interrogators 47 through 56 are respectively associated with signal-transmitting devices 57 through 66 which may take any convenient form to provide at the desired location along the conveyor the signals for energizing the responders respectively associated with the baggage articles. Thus, the signal transmitters may be inductance coils, electrostatic plates, shields, resonators, and combinations thereof depending upon the particular form of energizing signal produced by the interrogator units. In the embodiment considered herein, the signal transmitters 57 through 66 are coils, and it should be appreciated that while such signal transmitters are depicted as encircling the associated area of the conveyor, in the usual case a plurality of individual coils will be provided as, for example, one on each side of the conveyor and possible thereabove so as to be sure of providing a field through which each article of baggage must pass. Also in this respect, the coils may be oriented so that the energizing signal or signal field will have an angular disposition with respect to the longitudinal axis of the conveyor (45°, for example) since the optimum response to such signal is thereby attained.

Each article of baggage being advanced by the distribution conveyor 12 is equipped with an identification responder adapted to produce an article-identifying sonic signal of particular frequency corresponding to the destination of the article, and this is most conveniently provided by incorporating such responders in the tags exteriorly attached to each article of baggage and which tags also designate by visual identification the destination intended for the article. Thus, in FIG. 2 a typical article of baggage 67 is shown advancing along the conveyor section 12 toward the diverter 30, and it carries a tag 68 having incorporated therein a responder operative to provide a sonic signal used through the intervening agency of a sensor and control mechanism to actuate the proper diverter so that the article of baggage will be diverted along with others having the same group-identifying characteristics — i.e., destination.

The identification responder constitutes an energy transducer 69 operative to convert electromagnetic energy into sonic energy, and vice versa. Accordingly, the transducer may take various forms such as ceramic materials, electric coils, diaphragms and other devices having such conversion capability, and one specific example is a barium titanate transducer and another is a lead zirconate transducer, each of which in response to being energized by electromagnetic energy of one frequency in the ultrasonic range produces ultrasonic energy of essentially the same frequency, and vice versa. As shown in FIG. 2 the tag 68, which is made of a material such as stiff paper or paperboard that tends to minimize the attenuation of the energy forms to which the transducer is responsive and responds, encapsulates the transducer 69 therewithin. The transducer 69 may be excited by any appropriate means such as a pick-up coil 70 connected therewith and which is also encapsulated within the tag 68.

Essentially, the ultrasonic signals produced by the transducers 69 are non-directional, and disposed within the range of such signals is a sensor responsive to the various frequencies transmitted by the transducers 69 and which sensor may take a variety of forms. In the embodiment being considered, a plurality of individual sensors 71 through 80 are provided, and they are respectively equipped with pick-up heads or transducers 81 through 90 which are located within the transmission range of the transducers 69. The sensors 71 through 80 constitute appropriate circuitry to amplify the signals generated by the transducer heads 81 through 90 to a level sufficient to operate control mechanism which, in the form shown, comprises a plurality of relays 91 through 100, respectively connected with the sensors 71 through 80. Generally, the sensor can be of various types and is frequency-selective so as to operate in any one of several modes including single-frequency detection (the specific type shown in the embodiment illus-

trated), sweeping narrow-frequency-band detection from a broad spectrum of frequency signals, spectrum analyzer detectors, amplitude modulation continuous wave detectors, amplitude modulation detectors, frequency modulation detectors, phase detectors, code or pulse detectors, and other forms of detection best suited for any given installation. A particular embodiment of sensor is illustrated schematically in FIG. 5 and will be considered in detail hereinafter.

The transducer pick-up heads 81 through 90 can be different than but advantageously are the same as the transducers 69 heretofore discussed. In this respect then, the interrogators 47 through 56 respectively produce energizing or interrogating signals of particular frequency lying within the ultrasonic range. The frequency separation among the interrogators can be several hundred cycles or several thousand cycles depending upon the particular installation and the number of interrogators used. In a typical installation, the frequencies produced by the interrogators 47 through 56 will be respectively selected within the range of 25 kilocycles (i.e., above the sonic limit if a "silent" system is desired) to 100 kilocycles although higher frequencies are quite acceptable. It may be noted, however, that as the frequencies become much greater than about 200 kilocycles, energy losses appear and the sizes of the transducer components become excessively small.

The identification responders or transducers 69 will have frequencies respectively corresponding to the energizing frequencies of the interrogators 47 through 56 so that as a responder and the article with which it is associated is advanced by the conveyor section 12 through the energizing field defined by the energizing signals emanating from the signal transmitters 57 through 66, such responder will be energized by one particular interrogator and will produce an ultrasonic signal of particular frequency which will be picked up or sensed by the pick-up transducer and associated sensor tuned to such frequency. Such energization of the particular sensor will actuate the relay associated therewith which will actuate the corresponding diverter to cause the baggage article to be transferred from the conveyor section 12 to the proper assembly station.

By way of example, if the distribution branch 19 is intended to collect articles of baggage thereon having, say, Chicago for a destination, all of the articles of baggage intended for Chicago will carry a tag 68 corresponding to such destination, and such tags will have been placed upon the articles at one of the stations 16 through 18 in the usual manner. The tags 68 will, therefore, contain an identification responder 69 operative when energized to produce an ultrasonic signal of perhaps 50 kilocycles. The interrogators 47 through 56 are operative to continuously produce energizing signals at the transmitter devices 57 through 66 thereof, and one such interrogator (the unit 47, for example) is operative to produce an energizing signal having a frequency of 50 kilocycles. When each Chicago-bound article 67 is advanced by the distribution section 12 of the conveyor into the range of the energizing signal produced by the interrogator 47, the identification responder 69 is energized and produces an ultrasonic article-identifying signal having a frequency of 50 kilocycles. Such ultrasonic frequency will be picked up by the transducer 81 and amplified in the associated sensor 71 so as to actuate the relay 91 connected therewith. As a consequence, the diverter 30 will be actuated so as to cause the baggage article 67 to be shunted into the branch 19 which is intended to receive all Chicago-bound articles.

Each of the interrogators and respectively associated sensors (together with their pick-up heads and relays) will function in exactly the same manner to divert each article of baggage carrying a responder-equipped tag 68 operative to produce a signal corresponding to the flight destination represented by the interrogator unit, responder, diverter and distribution branch associated therewith. The flight destinations represented by any distribution branch can be changed by shifting the frequency of the interrogation or energizing

signals provided by the associated interrogator and sensor to a frequency descriptive of a different flight destination. The distribution branch 29 and continuously operative diverter or turn unit 40 associated therewith are provided to collect any articles of baggage that may fail to carry a suitable baggage tag, that for some reason might fail to be sensed by the proper interrogator and sensor units, which might be intended for flights leaving at some future date, etc., and must be manually inspected and directed to the appropriate locations therefor.

One specific embodiment of the interrogator unit is illustrated in FIG. 5, and it is essentially a crystal-controlled oscillator circuit operative to produce and transmit electromagnetic energizing signals via an inductance at a sonic frequency advantageously within the range of about 25 kilocycles to 100 kilocycles. The interrogator illustrated in FIG. 5 may be taken for positive identification as the interrogator 47, and the transmitter associated therewith is the inductance 57. The interrogator circuit is supplied with 24 volt DC power between ground and a supply line 101, a smoothing capacitance 102 being connected between such line and ground.

A voltage divider comprising resistances 103 and 104 serially connected between the line 101 and ground provides base potential for a transistor 105, the emitter of which is connected to ground by a biasing resistance 106 shunted by a capacitance 107. The collector of the transistor 105 is connected to the supply line 101 through an inductance 108 shunted by a variable padder capacitance 109. The crystal 110 is connected between the base and collector of the transistor 105 and determines the frequency of the oscillatory circuit comprising the same and, as stated hereinbefore, the frequency will be in the range of 25 to 100 kilocycles.

The oscillatory signal is inductance-coupled to an amplification stage by a transformer having the inductance 108 as the primary winding thereof and another inductance 111 as its secondary winding. The inductance 111 is connected between ground and the base of a transistor 112, the emitter of which is connected to ground by a resistance 113 which is shunted by a capacitance 114. The collector of the transistor 112 is connected to the supply line 101 through the aforementioned inductance 57 — the opposite side of which is grounded through a padder capacitance 115.

The circuit operates continuously so long as power is supplied thereto, and it produces an energizing or interrogation signal of a frequency determined by the circuit values and particularly the crystal 110. The energizing signal is transmitted across the conveyor by the coil 57 which, as shown in FIG. 3 and as indicated hereinbefore, is arranged with respect thereto so that each article being advanced by the conveyor is intercepted by the signal. Advantageously, all of the transmitting devices 57 through 66 may be enclosed within an electrostatic shield 116 which may be an aluminum enclosure so that only magnetic energy can be emanated by the system which ordinarily is not disruptive of electronic equipment generally associated with the operations of an airline terminal.

One specific embodiment of a sensor is shown in FIG. 6, and for purposes of positive identification may be taken to be the sensor 71. Accordingly, it has the aforementioned pick-up transducer 81 and relay 91 associated therewith. The circuit is essentially a receiver amplifier operative to convert the ultrasonic energy developed by the transducer 81 upon excitation thereof to electrical energy and amplify the same to a level adequate to energize the relay 91. The particular embodiment of the circuit illustrated is provided from a conventional power source with an operating voltage of +12 volts DC between ground and a supply line 117. A smoothing capacitance 118 is connected between the line 117 and ground.

The transducer 81 is connected through a coupling capacitance 119 to an input terminal of an integrated circuit 120 that produces at an output terminal thereof connected to a line 121 an amplified replica of the transducer signal fed thereto. The integrated circuit 120 may be a CA3035 (RCA) and the terminals 2, 8 and 10 thereof are directly grounded,

and the terminal 9 is grounded through a capacitance 122 and is also connected to the supply line 117 through a resistance 123. The terminals 3 and 4 of the integrated circuit are connected by a capacitance 124, and the terminals 5 and 6 are similarly connected by a capacitance 125. The input terminal 1 of the integrated circuit is connected to the terminal 3 thereof through serially related resistances 126 and 127 — the juncture of which is connected to the transducer 81 and capacitance 119. The same point of connection is grounded through a capacitance 128.

The rectification network comprising a coupling capacitance 129 and diodes 130 and 131 connect the output signal line 121 from the integrated circuit 120 to the base of a transistor 132. The emitter of the transistor 132 is grounded and the collector thereof is connected to the supply line 117 through the energizing coil of a relay 133. The supply line 117 is also connected via a resistance 134 to the output signal line 121. Ordinarily, the transistor 132 is reverse-biased and insufficient current flows therethrough to energize the relay 133. However, when the transducer 81 is excited, the transistor 132 conducts and the relay 133 (which is a resonant reed relay) is energized, thereby closing the contacts 135 thereof to complete the base circuit of a transistor 136 thereby causing it to conduct.

The emitter of the transistor 136 is connected to ground through the energizing coil of the aforementioned relay 91, and its collector is connected to the supply line 117 through a load resistance 137. In the usual instance, the transistor 136 has its base circuit open because the relay 133 is deenergized and insufficient emitter current flows through the transistor to energize the relay 91. When the relay 133 is closed in consequence of the transducer 81 being excited, a relatively large current flows in the emitter circuit of the transistor 136, thereby energizing the relay 91 and closing the contacts 138 thereof. As indicated hereinbefore, such relay forms a part of and controls the energizing circuit for the associated diverter, the diverter 30 for example, and when it is energized it actuates the diverter to cause it to transfer the article associated with a transducer-equipped tag 68 that excited the transducer head 81 into the assembly station defined by the branch conveyor 19.

For purposes of exemplification, typical components for the transmitter or interrogator circuit illustrated in FIG. 5 are as follows:

102 capacitance	100 microfarads
103 resistance	47 K ohms
104 resistance	47 K ohms
105 transistor	40316 (RCA)
106 resistance	220 ohms
107 capacitance	2.0 microfarads
108 inductance	10 millihenries
109 capacitance	2,200 picofarads
110 crystal	25 K cycles to 97 K cycles
111 inductance	1.0 millihenries
112 transistor	40316 (RCA)
113 resistance	220 ohms
114 capacitance	2.0 microfarads
115 capacitance	4,700 picofarads
57 inductance	20 turns on 4"x4" form of no. 18 enamelled copper wire

(inductances 108 and 111 comprise a ferrite core coupling transformer)

For purposes of exemplification, typical components for the receiver or sensor circuit illustrated in FIG. 6 are as follows:

118 capacitance	100.0 microfarads
119 capacitance	0.01 microfarads
120 integrated circuit	CA3035 (RCA)
122 capacitance	10.0 microfarads
123 resistance	1 K ohms
124 capacitance	0.03 microfarads
125 capacitance	0.002 microfarads
126 resistance	150 K ohms
127 resistance	33 K ohms
128 capacitance	0.01 microfarads
129 capacitance	0.01 microfarads
130 diode	1N914
131 diode	1N914

132 transistor	2N3858
133 relay	Magnecraft resonant reed relay 1,000 cycles per second 4.7 K ohms
134 resistance	2N2706
136 transistor	220 ohms
137 resistance	barium titanate 25 K cycles to 97 K cycles
81 transducer	Magnecraft reed relay
91 relay	

The signal field produced by each of the interrogator units 47 through 56 and the transmitter devices 57 through 66 respectively associated therewith can be made as large or as small as any particular installation may require, and any number of interrogator units may be employed to satisfy the requirements of any particular installation. The pick-up transducers 81 through 90 may be located at any position tending to give optimum reception, and it will be apparent that the positioning and orientation of the pick-up heads or transducers must be such that they are not directly energized by the signals produced by the interrogator units 47 through 56 — that is to say, in the case in which the identification responders 69 associated with the articles being advanced by the conveyor section 12 are the same as the pick-up transducers 82 through 90 associated with the sensors 71 through 80, they are each responsive at the particular frequency thereof to be energized by electromagnetic energy so as to produce ultrasonic energy of the same frequency or, alternatively, are capable of being energized by ultrasonic energy to produce electromagnetic energy at the same frequency. Thus, for the system to function properly, the pick-up transducers 82 through 90 must be respectively energized by the identification responders 69 and not directly by the interrogator units 47 through 56.

The identification responders 69 may be excited by single- or multiple-turn inductors associated therewith, whether printed or wound inductances, by plates, etc., largely in accordance with preference and cost considerations. Depending upon the simplicity or complexity of the coding systems desired, one or more identification responders 69 may be incorporated in each tag. Accordingly, and by way of example, code systems following a binary progression to any desired number might be employed, and in certain installations tertiary or quaternary codes might be employed as well as decimal codes, nano decimal codes, and so forth.

The system disclosed is effective to convert an electric energy field to ultrasound at particular frequencies for sorting purposes and embodies the ideal characteristic of employing a passive identification responder which is dormant until interrogated or energized by being subjected to an energizing signal having particular characteristics. The sonic system has the advantages of low cost, good definition and does not interfere with nor is it sensitive to interference from radio frequency electronic devices used in prevalence especially around an airline terminal. The sonic system also requires no particular orientation of the articles and the responder-equipped tags associated therewith. As indicated hereinbefore, a single sensor having multiple bands could be used rather than a plurality of individual sensor units as illustrated, but the several sensors have the advantage of obviating inter-frequency modulation that might occur in a multiple-band sensor unless adequate shielding were provided, and since the units are simple and of low cost it is convenient to provide a multiplicity thereof each equipped with its own pick-up transducer and control relay. It might be observed that a modulated carrier frequency can be used with the system to eliminate spurious responses in installations in which this refinement would be an advantage. In this same general context, signal patterns can be shaped so that there is no interference between successive articles being advanced along the conveyor.

The described baggage-handling system requires the use of no carts or other carriers for the individual pieces of baggage because no special orientation of the articles is required in order to be sensed by the appropriate interrogation units. The system lends itself to passenger tagging of the baggage since it is only necessary to select a tag for the proper destination and

attach it to the article of baggage in any manner since, as stated, precise positioning of the article of baggage or the tag thereon is not essential. In a physical sense, the distribution section 12 could extend along a tunnel or passageway underlying the walkways from the main terminal building to the various loading stations, and the distribution branches could extend directly to the service area associated with the loading stations. All of the conveyor mechanisms may be completely conventional and can be of the type now in use to transport baggage from one location to another at an airline terminal. In such event, the conveyor mechanisms ordinarily will comprise endless belts which are more suitable to handling odd-shaped pieces of baggage than are roller-type conveyors.

The system is applicable to the handling and distribution of articles and materials generally as well as for processing baggage at airline terminals and, for example, the distribution of parts and components in various manufacturing plants (an automobile assembly line, for example) is another typical use. In any event, the particular articles being processed are self-identifying, and therefore take an active part in selecting the routes leading to their appropriate destinations, and accomplish such selection wholly without human intervention. It will be appreciated that in a system such as shown in FIG. 1 in which the interrogator units 47 through 56 are grouped at a location remote from the diverters 30 through 39, the control means comprising the relays 91 through 100 must include an arrangement for delaying the movement of each article into the diverter area of the conveyor until the immediately preceding article has cleared the same, or include some other analogous arrangement to prevent interference or confusion between successive articles such as interlocking switch controls, sequencing switches, etc.

As stated hereinbefore, use of a modulated interrogator signal may be desirable in certain installations such as those in which there otherwise might be a considerable likelihood of the sensors being subjected to spurious energizing signals occasioned by random ultrasonic noise generated by agencies other than an identification responder 69. The modified embodiments of the interrogator and sensor units respectively shown in FIGS. 7 and 8 have such signal characteristics; and in this respect the interrogator or transmitter unit incorporates a tone modulator operative to modulate the ultrasonic carrier signal produced by the interrogator, and the sensor or receiver unit incorporates a tone detector operative to detect the modulation signal component superimposed on the ultrasonic frequency carrier signal component. The sensor or receiver unit is therefore essentially insensitive to spurious forms of ultrasonic sound generated in the system or sensed thereby.

Generally, the transmitter or interrogator unit illustrated in FIG. 7 may be subdivided into three general networks respectively comprising a tone-encoder modulator network 140, an ultrasonic oscillator network 141, and an amplifier network 142. The network 140 is essentially a two-stage high-impedance audio oscillator with a resonant reed relay or piezofork providing the feedback path between the two oscillator stages, and with an emitter-follower stage providing a low-impedance output for the network. The ultrasonic oscillator network 141 is amplitude-modulated by the tone-encoder modulator network 140, and the low-impedance emitter-follower stage provides the input path for the modulation signals delivered to the oscillator network. The amplifier network 142 includes a driver as its input stage serving to couple the oscillator network 141 to a class B power amplifier having a center tapped output transformer feeding one of the aforementioned inducer or signal-transmitting devices 47 through 66.

Considering in greater particularity the details of the transmitter or interrogator unit illustrated in FIG. 7, the circuit thereof is supplied with 24 volt DC power between a positive supply line 143 and ground line 144. A voltage dropping resistance 145 is interposed in the supply line 143, and a smoothing capacitance 146 is connected between the low voltage side 147 of the resistance 145 and the ground line 144. Thus, power constituting a positive DC voltage is supplied to

the stages and components of the various networks 140, 141 and 142.

As indicated hereinbefore, the tone-encoder modulator network 150 includes a two-stage high-impedance audio oscillator, the stages of which respectively comprise NPN transistors 148 and 149. The emitter of the transistor 148 is connected to ground through a resistance 150, the collector is connected directly to the supply line 147, and the base of the transistor is connected to the supply line 147 through a resistance 151. The emitter of the transistor 149 is grounded through a resistance 152, the collector is connected to the supply line 147 through a resistance 153, and the base of the transistor 149 is connected to the emitter of the transistor 148 through a series related resistance 154 and capacitance 155.

The feedback path between the oscillator stages respectively comprising the transistors 148 and 149 is provided by a resonant reed relay 156 connected between the collector of the transistor 149 and base of the transistor 148. One terminal of the relay 156 is grounded, as shown. The relay 156 is quite sensitive and has a very narrow band width which, by way of example, may be of the order of two cycles per second at a frequency of approximately 1,000 cycles per second. The output of the audio oscillator is taken through an emitter-follower stage comprising an NPN transistor 157 having its emitter connected to ground through a resistance 158 and its collector connected directly to the supply line 147. The base of the transistor 157 is connected to the emitter of the transistor 148 through a coupling capacitance 159, and biasing voltage for the base is derived from a voltage divider comprising serially connected resistances 160 and 161 connected between the supply line 147 and ground line 144. Analogously, the biasing voltage for the base of the transistor 149 is provided by a voltage divider comprising serially connected resistances 162 and 163 connected between the supply line 147 and ground.

The ultrasonic oscillator network 141 comprises a pair of transistors 164 and 165 that are directly connected collector-to-emitter. The emitter of the transistor 164 is connected to ground through a resistance 166, and the collector of the transistor 165 is connected to the supply line 147 through a tank or tuned circuit comprising a shunt-connected inductance 167 and capacitance 168. A feedback capacitance 169 is connected between the base of the transistor 165 and a tap of the inductance 167 which is variable so as to provide fine frequency control over the carrier wave frequency generated by the network 141. The oscillatory frequency could be crystal-controlled by replacing the feedback capacitance 169 with a crystal of the appropriate frequency. The base of the transistor 164 is connected to the emitter of the transistor 157 comprising the emitter-follower stage through a series resistance 170, and the base of the transistor 165 is similarly connected to the emitter of the transistor 157 through a coupling capacitance 171. Base bias for the transistor 165 is provided by a voltage divider comprising serially connected resistances 172 and 173 that are connected between the supply line 147 and the ground line 144.

The oscillator network 141 generates an ultrasonic carrier frequency which, as indicated hereinbefore, is advantageously within the range of about 25 to 100 kilocycles. This carrier signal is modulated by the audio frequency signal generated in the network 140, and which modulation signal is transmitted to the oscillator network 141 through the emitter-follower stage comprising the transistor 157. The composite signal comprising the carrier frequency having the audio modulation signal superimposed thereon is fed to the amplifier network 142 from the collector of the transistor 165.

The amplifier network 142 includes a driver stage comprised of an NPN transistor 174, the emitter of which is connected to ground through a resistance 175 and the collector of which is connected to the supply line 147. The base of the transistor 174 is connected to the ultrasonic oscillator network 141 through a coupling capacitance 176, and bias is provided for the base through a voltage divider comprising resistances 177 and 178 which are connected in series between the supply line 147 and ground.

The driver stage feeds a power amplifier comprising NPN transistors 179 and 180 that are connected in a class B amplifier configuration. The bases of the transistors 179 and 180 are connected together through the secondary winding 181 of a coupling transformer 182 which has its primary winding 183 connected to ground and to the emitter of the transistor 174 through a blocking capacitance 184. Bias for the base elements of the transistors 179 and 180 is provided through a voltage divider constituting resistances 185 and 186 that are connected in series between the supply line 143 and ground line 144 and the juncture of which resistances is connected to the center tap of the secondary transformer winding 181. The emitters of the two transistors 179 and 180 are grounded, and the collectors thereof are connected together through the primary winding 187 of an output transformer 188 having a secondary winding 189 feeding the appropriate signal transmitting device which may be an 8 to 10 ohm inductance. The primary winding 187 has a center tap connected directly to the voltage supply line 143. A smoothing capacitance 190 is connected between the supply line 143 and ground line 144, and serves substantially the same function as the aforementioned capacitance 146.

The amplifier network 142 serves to amplify the composite signal delivered thereto through the coupling transformer 182, and which signal comprises the ultrasonic carrier frequency modulated by the audio frequency signal superimposed thereon. The driver stage comprising the transistor 174 is able to produce power of the order of 200 milliwatts (in a particular embodiment of the circuit, the values of which will be set forth hereinafter), and the power transformer comprising the transistors 179 and 180 is capable of about 1 to 15 watts of output in such circuit embodiment and usually will be operated at about the 3 to 5 watt level. The amplified output signal delivered to the appropriate signal transmitting device 57 through 66 is adapted to be intercepted by an identification responder, as heretofore explained, and the low impedance of such device in the case of its being an 8 to 10 ohm inductance advantageous in that it enables an identification responder (transducer 69) when having a higher impedance pick-up to effect a voltage step-up.

Turning now to the receiver or sensor unit illustrated in FIG. 6, it comprises an amplifier network 191, a first detector network 192, a tone decoder network 193, an audio amplifier network 194, a second detector network 195, and a relay-driver output network 196. The various stages and elements of the sensor unit are supplied with 12 volt positive DC power between a supply line 197 and ground line 198. The sensor unit is operative to receive radiant energy waves propagated by an identification responder or transducer 69, and which propagated waves comprise a carrier wave at an ultrasonic frequency having an audio frequency signal superimposed thereon. In more explicit terms, each transducer 69 is operative to transmit or propagate radiant energy waves constituting a signal counterpart of the electromagnetic signal that effected its energization, and which energizing signal was imparted thereto via one of the signal transmitting devices 57 through 66. Accordingly, in the case of the transmitter or interrogator unit illustrated in FIG. 7 which is operative to provide an energizing signal constituted of a carrier signal component and a modulating signal component superimposed thereon, the transducer 69 energized by such signal propagates a counterpart signal constituting a carrier wave signal component having an audio frequency signal component superimposed thereon which is received or sensed by the unit shown in FIG. 8 which functions to detect such signal and particularly the modulation component thereof.

Considering the receiver or sensor unit in greater detail, the amplifier network 191 thereof is a high-gain amplifier operative to enhance or amplify the signals picked up by the associated pick-up head or transducer (i.e., one of the transducers 81 through 90). The amplifier network includes an integrated circuit generally denoted with the numeral 199, and one side of the associated transducer is coupled to the input of the circuit 199 through a capacitance 200, and the other side

of the transducer is connected to the ground line 198. Automatic gain control is provided for the amplifier network 191 to prevent overloading at high input signal levels which otherwise could result in losing at least some of the modulation component of the input signal due to clipping action. Such gain control is provided by a pair of diodes 201 and 202 that are connected in series between the ground line 198 and the input terminal of the integrated circuit 199 through a resistance 203 in series connection with the diode 202. The juncture of the diodes 201 and 202 is connected to the output terminal 204 of the integrated circuit through a feedback capacitance 205.

Certain of the terminals of the integrated circuit 199 are connected together through a capacitance 206, one side of which is connected to the input terminal of the circuit 199 through series connected resistances 207 and 208. The juncture of the resistances 207 and 208 is provided with an AC pass to ground through a capacitance 209. Other terminals of the integrated circuit 199 are interconnected, as shown, and in one instance a capacitance 210 provides such interconnection, and one side of the capacitance is connected to the supply line 197 through a resistance 211. It may be observed that a smoothing capacitance 212 is connected between the supply line 197 and the ground line 198, as shown. Still another terminal of the circuit 199 is connected to the supply line 197 through a resistance 213.

The amplified signal from the network 191 is fed to the first detector network 192 through a coupling capacitance 214 that is connected between the output terminal 204 of the integrated circuit 199 and the base of a PNP transistor 215 comprising such first detector network. Biasing voltage for the base of the transistor 215 is provided through a voltage divider comprising resistances 216 and 217 that are connected in series between the supply line 197 and ground line 198. The emitter of the transistor 215 is connected to ground through a resistance 218, and the collector of the transistor is connected directly to the voltage supply line 197. The first detector network 192 is operative to remove the carrier frequency signal of the amplified signal delivered thereto, and to provide at its output an audio frequency signal constituting the modulation component of the input signal thereto and which, in accordance with the previous suggestion, will have a frequency of about 1,000 cycles per second.

The tone decoder network 193 is essentially a very sharp, selective tone amplifier which in a particular instance of the circuit has a band width of about 2 cycles. The network 193 comprises a pair of transistors 219 and 220 — the first of which has its emitter connected to ground through a resistance 221 and its collector connected directly to the supply line 197. The base of the transistor 219 receives the audio output signal from the first detector network 192 through a coupling capacitance 222 connected between the base of the transistor 219 and emitter of the transistor 215. Bias voltage for the base of the transistor 219 is provided by a voltage divider network comprising serially connected resistances 223 and 224.

The signal from the transistor 219 is taken from the emitter element thereof, and is connected to the base of the transistor 220 through a filter comprising a resonant reed relay or piezofork 225 having a narrow band width of the order of two cycles at a frequency of about 1,000 cycles per second. A resistance 226 is connected between the filter relay 225 and the base of the transistor 220 which has bias voltage applied thereto through a voltage divider comprising series connected resistances 227 and 228. One terminal of the relay 225 is grounded, as shown. The emitter of the transistor 220 is connected to ground through a resistance 229, and the collector is connected to the supply line 197 through a load resistance 230.

The audio amplifier network 194 is used to compensate for signal losses occurring in the tone decoder network 193 and increases the level of the audio frequency signal to a value suitable for processing in the second detector network 195.

The audio amplifier network 194 includes a transistor 231 — the emitter of which is grounded through a resistance 232 and the collector of which is connected to the supply line 197 through a load resistance 233. Bias for the base of the transistor 231 is derived from a voltage divider comprising resistances 234 and 235. A coupling capacitance 236 is connected between the emitter of the transistor 220 and base of the transistor 231 so as to deliver the output signals from the decoder network 193 to the amplifier network 194.

The second detector network 195 receives the amplified audio frequency signal from the network 194 and produces therefrom a DC output signal the magnitude of which is directly related to the intensity of the demodulated audio signal delivered thereto and which is derived from the transducer 69 having a frequency sensed by the transducers 81 through 90 forming a part of the receiver circuit. The detector network 195 includes a pair of diodes 237 and 238 together with a capacitance 239. A coupling capacitance 240 delivers the audio signals to the detector and it is connected between the collector of the transistor 231 and junction of the serially connected diodes 237 and 238. One side of the diode 237 is connected to ground, and the opposite side of the diode 238 is connected to ground through capacitance 240.

The relay-driver output network 196 includes a pair of transistors 241 and 242 that are connected emitter-to-base. The base of the transistor 241 receives the DC signal output from the detector network 195 and is connected directly to the juncture of the diodes 238 and capacitance 239. The collector of the transistor 241 is connected directly to the supply line 197, and the collector of the transistor 242 is connected to the supply line 197 through the energizing coil 243 of a relay 244 and a diode 245 connected in shunt with such coil 243. The emitter of the transistor 242 is connected to ground through a resistance 246. The transistors 241 and 242 are connected in a Darlington configuration to drive the relay 244. Whenever the relay coil 243 is energized the relay contacts are closed, thereby providing an indication of the presence at the aforementioned station 46 of an article 67 having the transducer 69 associated therewith propagating a signal having a carrier signal component the frequency of which is detectable by the receiver or sensor unit. The terminals of the relay 244 are connected to one of the aforementioned relays 91 through 100 to energize the same.

It will be appreciated that if the transmitter and receiver units respectively illustrated in FIGS. 7 and 8 are used, a plurality of transmitter units and a plurality of receiver units will be employed, as explained hereinbefore, in respective association such that when an article moving along the conveyor 12 passes through the station 46, the transducer carried by such article will be energized by the signals from one of the transmitter or interrogator units, and the signals propagated by such transducer will be received by the appropriately tuned receiver or sensor unit, whereupon the output relay 244 thereof will be energized so as to actuate the particular relay 91 through 100 associated therewith.

For purposes of exemplification, typical components for the transmitter or interrogator circuit illustrated in FIG. 7 are as follows:

145 resistance	220 ohms
146 capacitance	100 microfarads
148 transistor	2N3858
149 transistor	2N3858
150 resistance	10 K ohms
151 resistance	100 K ohms
152 resistance	1.0 K ohms
153 resistance	5.6 K ohms
154 resistance	1.0 K ohms
155 capacitance	10 microfarads
156 resonant reed relay Murata Microfork, 1,000 cycles per second	
157 transistor	2N3053
158 resistance	470 ohms
159 capacitance	
160 resistance	100 K ohms
161 resistance	100 K ohms
162 resistance	33 K ohms

163 resistance	4.7 K ohms
164 transistor	2N 3858
165 transistor	2N 3053
166 resistance	12 ohms
167 inductance, variable-	
168 capacitance	0.22 microfarads
169 capacitance	0.05 microfarads
170 resistance	57 K ohms
171 capacitance	0.01 microfarads
172 resistance	22 K ohms
173 resistance	4.7 K ohms
174 transistor	2N3053
175 resistance	510 ohms
176 capacitance	0.01 microfarads
177 resistance	10 K ohms
178 resistance	10 K ohms
179 transistor	40316
180 transistor	40316
181 secondary winding	1.5 K ohms
182 transformer	
183 primary winding	500 ohms
184 capacitance	0.1 microfarads
185 resistance	2.2 K ohms
186 resistance	27 ohms
187 primary winding	150 ohms
188 transformer	
189 secondary winding	8.0 ohms
190 capacitance	10 microfarads

25 For purposes of exemplification, typical components for the receiver or sensor circuit illustrated in FIG. 8 are as follows:

199 integrated circuit	CA3035
200 capacitance	0.01 microfarads
201 diode	1N82A
202 diode	1N82A
203 resistance	10 K ohms
205 capacitance	0.01 microfarads
206 capacitance	0.01 microfarads
207 resistance	47 K ohms
208 resistance	22 K ohms
209 capacitance	0.01 microfarads
210 capacitance	1.0 microfarads
211 resistance	1.0 K ohms
212 capacitance	100 microfarads
213 resistance	4.7 K ohms
214 capacitance	0.01 microfarads
215 transistor	2N1415
216 resistance	47 Ohms
217 resistance	4.7 K ohms
218 resistance	5.6 K ohms
219 transistor	2N3858
220 transistor	2N3858
221 resistance	10 K ohms
222 capacitance	10 microfarads
223 resistance	100 K ohms
224 resistance	100 K ohms
225 resonant reed relay Murata Microfork 1,000 cycles per second	
226 resistance	100 K ohms
227 resistance	220 K ohms
228 resistance	100 K ohms
229 resistance	1.0 K ohms
230 resistance	47 K ohms
231 transistor	2N3858
232 resistance	220 ohms
233 resistance	4.7 K ohms
234 resistance	47 K ohms
235 resistance	4.7 K ohms
236 capacitance	10 microfarads
237 diode	1N82A
238 diode	1N82A
239 capacitance	10 microfarads
240 capacitance	10 microfarads
241 transistor	2N3858
242 transistor	2N3858
243 coil	
244 relay	
245 diode	1N914
246 resistance	10 ohms

While in the foregoing specification embodiments of the invention have been set forth in considerable detail for purposes of making a complete disclosure thereof, it will be apparent to those skilled in the art that numerous changes may be made in such details without departing from the spirit and principles of the invention.

75 What is claimed is:

1. An article-identifying tag for attachment to an article to be identified thereby, comprising a passive transducer normally dormant but operative when subjected to electromagnetic energy having particular frequency characteristics to transmit ultrasonic energy of substantially the same frequency characteristics and vice versa, and a carrier adapted to be attached to such article and providing a mounting for said transducer, said transducer being comprised of barium titanate and being substantially encapsulated within said carrier so as to be mechanically protected thereby, and said carrier being characterized by affording relatively little attenuation of the ultrasonic and electromagnetic energy to which said transducer is responsive.

2. In an article-identification system, an interrogator operative to produce at a particular location through which such article passes an electromagnetic energizing signal comprising a carrier signal having a frequency in the ultrasonic range and an amplitude-modulating audio signal superimposed thereon, an identification responder for transport in association with such article through said location and being responsive to such energizing signal to propagate an article-identifying counterpart signal comprising ultrasonic carrier signal waves and an amplitude-modulating audio signal superimposed thereon, and a sensor receptive to said article-identifying signal and operative in response to the amplitude-modulating audio signal component thereof to evidence the presence of said identification responder and associated article at said location.

3. The article-identification system of claim 2, in which said interrogator comprises an oscillator network operative to produce an output carrier signal having a frequency in the ultrasonic range, a tone encoder network operative to produce a modulation signal having a frequency in the audio range and being connected with said oscillator network so as to amplitude-modulate the output carrier signal thereof with such audio frequency signal, a power amplifier network coupled to said oscillator network to receive such modulated carrier signal therefrom and produce an amplified replica thereof, and a signal-transmitting device connected with said power amplifier to receive such amplified signal replica therefrom and present the same as such energizing signals at said location.

4. The article-identification system of claim 3, in which said encoder network includes a two-stage high-impedance audio oscillator comprising a pair of transistors respectively forming components of said two stages and further comprising a resonant reed relay device connected with said transistors to provide a feedback path between said stages.

5. The article-identification system of claim 4, in which said encoder network further includes an emitter-follower stage providing a low-impedance coupling between said encoder and oscillator networks and comprising a transistor connected with said audio oscillator in such emitter-follower configuration.

6. The article-identification system of claim 5, in which said power amplifier network includes a pair of transistors connected in a class B amplifier configuration, and further includes a driver stage comprising a transistor interconnecting said class B amplifier and said oscillator network.

7. The article-identification system of claim 2 in which said sensor comprises a signal transducer responsive to said amplitude-modulated ultrasonic carrier signal waves propagated thereto to produce counterpart electric signals comprised of amplitude-modulated carrier signals, a receiver-amplifier network connected to said transducer to receive such counterpart electric signals therefrom and amplify the same, a first detector network connected to said receiver-amplifier network to receive such amplified signals therefrom and to produce a detector-output signal having the same frequency characteristics of the amplitude modulation imposed upon such carrier signals, a tone decoder network connected to said detector network to receive such output signals therefrom and to produce sharpened replicas thereof having a narrow band

width, a second detector network coupled to said tone decoder network to receive such signal replicas therefrom and to produce a DC signal output proportional to the intensity of such signal replicas, and an output network connected to said second detector network to receive such DC signal output therefrom and provide response thereto indicative of energization of said transducer by propagation of such signal waves thereto.

8. The article-identification system of claim 7, in which said transducer is responsive to ultrasonic carrier signal waves of a predetermined frequency and produces counterpart electric carrier signals at substantially the same predetermined frequency, and in which the modulation of such ultrasonic and carrier signals is at an audio frequency.

9. The article-identification system of claim 8, in which said tone decoder network constitutes a selective tone amplifier comprising a pair of transistors and a resonant reed relay connected therebetween and serving as a narrow band width filter.

10. The article-identification system of claim 9, and further comprising an audio amplifier network connected between said tone decoder and second detector networks to compensate for signal loss in said tone decoder network by amplifying the signal output thereof to higher levels for said second detector network.

11. The article-identification system of claim 8, in which said interrogator comprises an oscillator network operative to produce an output carrier signal having a frequency in the ultrasonic range, a tone encoder network operative to produce a modulation signal having a frequency in the audio range and being connected with said oscillator network so as to amplitude-modulate the output carrier signal thereof with such audio frequency signal, a power amplifier network coupled to said oscillator network to receive such modulated carrier signal therefrom and produce an amplified replica thereof, and a signal-transmitting device connected with said power amplifier to receive such amplified signal replica therefrom and present the same as such energizing signals at said location.

12. The article-identification system of claim 11, in which said transducer is responsive to ultrasonic carrier signal waves of a predetermined frequency and produces counterpart electric carrier signals at substantially the same predetermined frequency, and in which the modulation of such ultrasonic and carrier signals is at an audio frequency.

13. The article-identification system of claim 12, in which said encoder network includes a two-stage high-impedance audio oscillator comprising a pair of transistors respectively forming components of said two stages and further comprising a resonant reed relay device connected with said transistors to provide a feedback path between said stages, and in which said encoder network further includes an emitter-follower stage providing a low-impedance coupling between said encoder and oscillator networks and comprising a transistor connected with said audio oscillator in such emitter-follower configuration.

14. The article-identification system of claim 13, in which said tone decoder network constitutes a selective tone amplifier comprising a pair of transistors and a resonant reed relay connected therebetween and serving as a narrow band width filter.

15. In an article-identification system, an interrogator operative to produce at a particular location through which such articles pass a plurality of electromagnetic energizing signals each having a frequency in the ultrasonic range, a plurality of normally dormant identification responders for transport in respective association with such articles through said location and each being operative in response to a particular energizing signal to propagate an ultrasonic article-identifying counterpart signal, and a plurality of sensors respectively receptive to a particular article-identifying signal and operative in response thereto to evidence the presence of the signal-propagating identification responder and associated article at

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said location, said electromagnetic energizing signals each having predetermined characteristics making it distinct from the others and said identification responders being respectively responsive to such energizing signals to produce ultrasonic article-identifying signals of different particular frequencies, whereby a plurality of articles passing through said particular location can be distinguished one from another in accordance with the characteristics of the article-identifying signal associated therewith.

16. An article-identifying tag for attachment to an article to be identified thereby, comprising a carrier adapted to be attached to such article and providing a mounting for a trans-

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ducer, and a transducer supported by said carrier and having the inherent characteristic of effecting energy conversions between electromagnetic and ultrasonic energy, said transducer being passive and normally dormant but operative when subjected to electromagnetic energy having particular frequency characteristics substantially within the ultrasonic range to transmit ultrasonic energy.

17. The article-identifying tag of claim 16, in which said transducer effects conversion between electromagnetic and ultrasonic energy at substantially the same frequency.

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