Feb. 3, 1959 F. A. MEUNIER 2,871,940

CONTINUOUS CONTROL FOR STRIP MILLS AND THE LIKE

Filed July 15, 1954 3 Sheets-Sheet 1

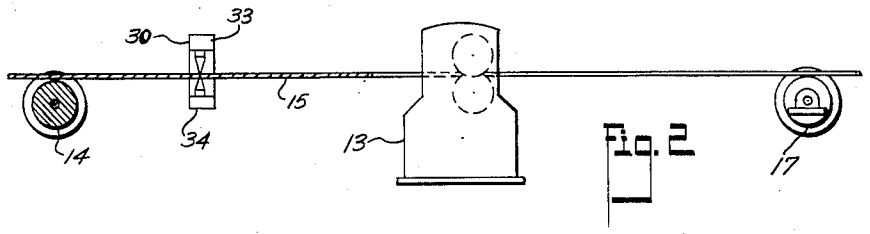


Fig. 2

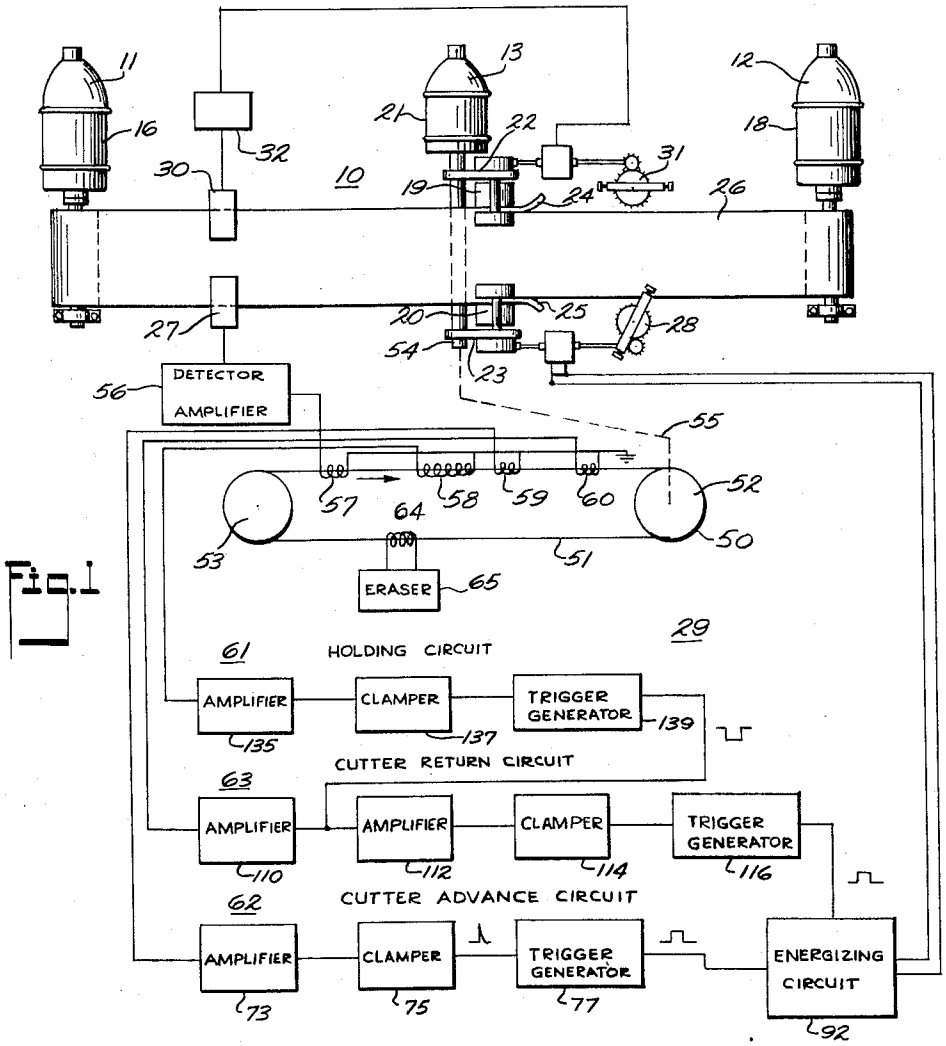


Fig. 1

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CONTINUOUS CONTROL FOR STRIP MILLS AND THE LIKE

Filed July 15, 1954 3 Sheets-Sheet 2

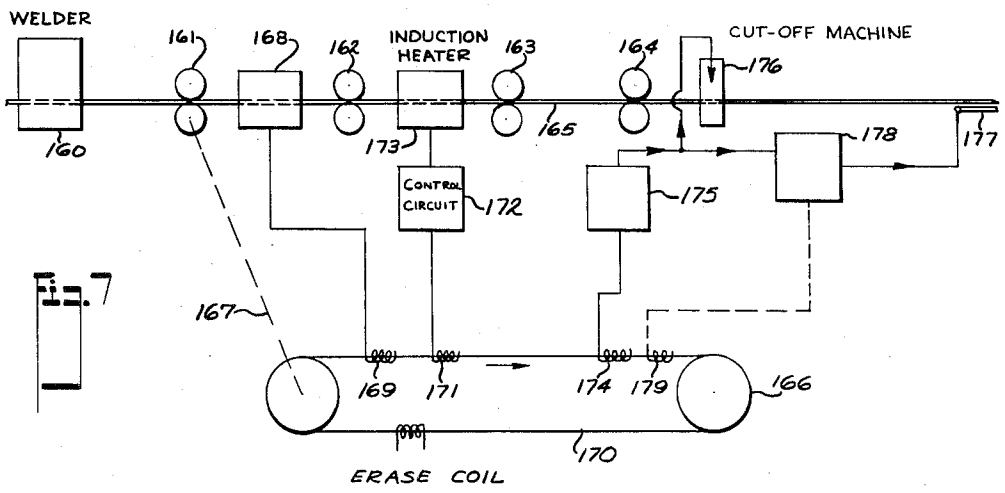


Fig. 7

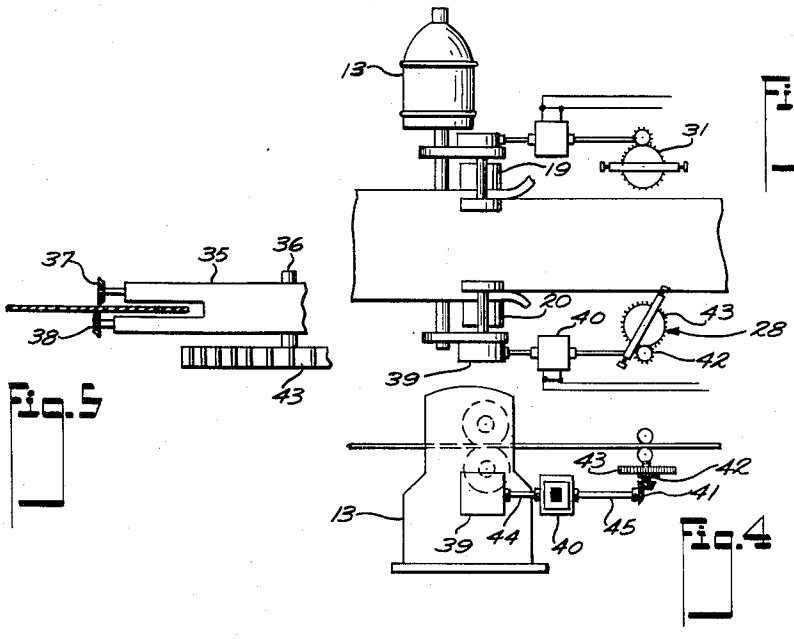


Fig. 3

Fig. 5

Fig. 4

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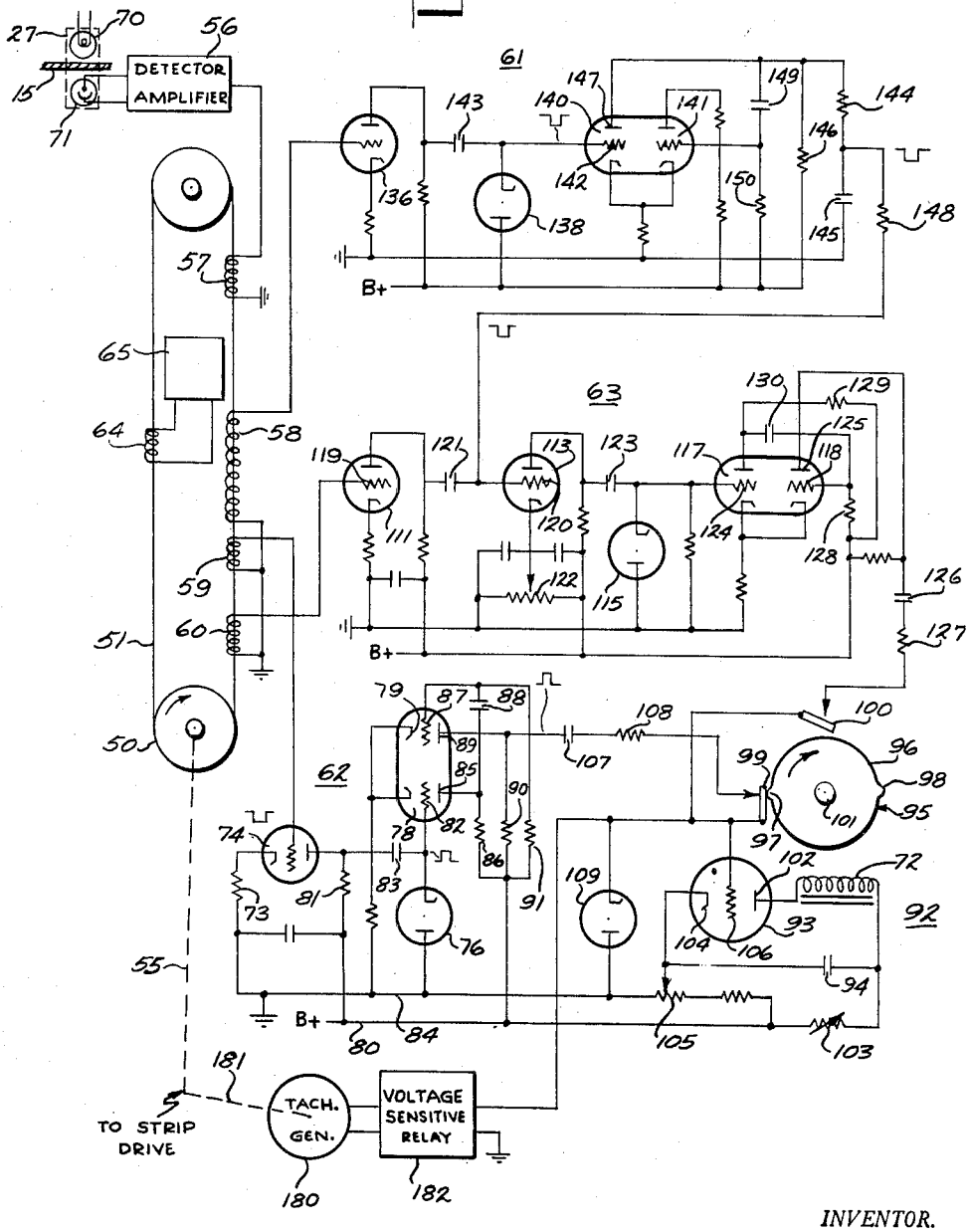
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CONTINUOUS CONTROL FOR STRIP MILLS AND THE LIKE

Filed July 15, 1954 3 Sheets-Sheet 3

Fig. 6



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2,871,940

CONTINUOUS CONTROL FOR STRIP MILLS AND THE LIKE

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Application July 15, 1954, Serial No. 443,651

14 Claims. (Cl. 164—61)

This invention relates to a method of and means for detecting and removing defects in continuous strips and, more particularly, to a method of and means for controlling operations upon a continuously moving strip in accordance with recorded electrical signals indicative of the condition of the strip at any particular point thereof.

In the manufacture of sheet steel, the steel stock is passed through rolls which reduce the gauge of the stock progressively to the desired thickness, the final product of the rolling operation being a long strip of sheet metal which is coiled or rolled for further processing. After the rolling is completed, the strip is passed through a slitting line in which the edges of the stock are trimmed to provide stock of a standard width with straight edges. The stock may then be tin plated or galvanized and, subsequently, may be cut into sheets.

During the rolling process, the strip develops an uneven margin which is removed by the slitting operation. In addition, however, small tears or cracks may be formed which extend inwardly from the edge of the strip. If these cracks or tears are confined to the marginal portion which is removed in the slitting line, they are not a matter of concern. However, the defects often extend into the otherwise usable portion of the strip which remains after the slitting operation. When stock with such marginal defects is fed through a plating line, the sharp corners of the break formed by the defect may catch on the machinery and cause the strip to be torn across its entire width. This is a serious hazard, since, if the strip is torn as, e. g. in an electrolytic tin plating mill, the entire mill must be shut down with a resulting loss in time, demaged material and poorly plated stock.

This hazard can be eliminated by cutting out the marginal part of the strip where a crack occurs in such a manner as to eliminate the sharp corners. This may be accomplished, for example, by removing an arcuate section from the edge of the strip so that no sharp corners are present to catch on equipment.

My application, Serial No. 152,740, filed March 29, 1950, now Patent No. 2,735,329, of which this application forms a continuation-in-part discloses a novel apparatus for detecting the marginal defects in the sheet strip. The apparatus of that application included not only a means for marking the edge of the strip to indicate such defects, but also a tear remover whereby the defective portion of the strip might be removed without shutting down the particular line in which the inspection process was carried on.

The present application is concerned with a method and means whereby the above-described marking or tear removing operations may be controlled by means of electrical signals which are derived from the device which detected the flaws. The signals are recorded upon a continuously moving magnetic recorder which is driven at the speed of the strip being inspected, or at some speed which is in a fixed ratio to that speed, and the

recorded impressions are successively utilized to operate electrical circuits which, in turn, control the various operations upon the strip.

It is an important aspect of the invention that the impression produced upon the record medium moves along a path which corresponds to the movement of the defect which produced the impression along the processing line.

As herein disclosed and described, the device is embodied in several forms. In the first embodiment, the recorded impressions are utilized to control a machine positioned along the processing line and either a complete operation or separate portions of the same operation, each portion thereof being under independent control by the recorder. In another embodiment of the invention, the recorded impressions are utilized to control a plurality of independent machines positioned at spaced intervals along the processing line.

It is an object of the invention to control a number of different operations or different parts of the same operation upon a continuously moving strip or the like by means of electrical signals originally derived in response to irregularities present in the strip.

Another object of the invention is to control a plurality of machines or separate operations by the same machine by means of a recorded medium which moves with a work piece which is transported along a processing line.

Still another object of the invention is the control of production processes generally in which operations are conducted upon different portions of a moving work piece and the initiation and termination of those operations must be conducted with reference to the location of portions of the work piece.

A still further object of the invention is to provide a memory system for production inspection apparatus which is simple and yet provides precise control of mechanical apparatus.

Other objects, features and advantages of the invention will be more readily apparent from a consideration of the following detailed description and claims taken in connection with the accompanying drawings, in which:

Fig. 1 is a schematic representation of a strip mill embodying one form of the invention and representing electrical circuits in functional form;

Fig. 2 is a vertical section of the strip mill of Fig. 1 taken in the direction 2—2;

Figs. 3, 4 and 5 are enlarged views of the tear remover of Fig. 1;

Fig. 6 is a schematic diagram showing particularly the electrical circuits of the apparatus of Fig. 1; and

Fig. 7 is a schematic representation of a tube mill embodying one form of the invention.

Referring now to Fig. 1, there is shown a slitting line 10 for steel strip which includes a feed mechanism 11, a take-up or winding mechanism 12 and a trimmer 13. The feed mechanism includes a feed roll 14 which carries a roll of strip 15 and is driven by a motor 16. The take-up mechanism 12 comprises a second similar roll 17 and is driven by an electric motor 18. Appropriate means, well known to those skilled in the art, are utilized to cause the motors 16 and 18 to drive the rolls 14 and 17 at synchronous speeds.

The trimmer 13 comprises a rotary shears 19 at one edge of the strip and a second similar shears 20 at the remaining edge of the strip. The shears 19 and 20 are driven by a motor 21 at a speed corresponding to the speed of the strip, and remove the edge portions 24 and 25 so as to produce a finished strip 26 of uniform width and having smooth edges.

The process control apparatus of the invention comprises a photoelectric detector head 27 which is mounted

adjacent the edge of the strip ahead of the trimmer 13, a tear remover 28 for removing selected portions of the edge of the strip, and electric circuit means 29 for controlling the operation of the tear remover 28 in response to signals from the detector head 27. A second similar arrangement including a detector head 30, a tear remover 31 and an electric circuit means 32 is provided for removing tears from the remaining edge of the strip.

The detector head 30 is shown in more detail in Fig. 2 and comprises a U-shaped housing member including arms which project inwardly over the strip. The upper portion of the housing encloses an incandescent lamp which is utilized as a light source and suitable lenses for directing the light against the strip 15. The lower arm 34 encloses a photoelectric cell and a suitable lens arrangement for directing any light which is transmitted through breaks or other defects in the strip upon the cathode of the photoelectric cell. The detector head 27 is, of course, positioned so that the portion of the strip inspected extends inwardly from the edge portion of the strip after trimming. The first-named detector head 27 is of the same construction as the above-described detector head 30.

The tear remover shown herein comprises a device having a rotary cutting wheel which may be carried into and out of engagement with the strip 26. The device includes an arm 35 which is supported by a vertical shaft 36 so as to rotate in the plane of the strip 26. The arm 35 is bifurcated at each end thereof so that the separate parts of the arm may pass above and below the strip. Two cutter wheels 37 and 38 are carried at the one end of the arm as shown in Fig. 5, while a second similar pair of cutter wheels are carried at the remaining end of the arm.

The arm 35 is driven from the trimmer 13 by means of a power take-off 39, an electrically controlled single revolution clutch 40, a bevelled gear 41 and a pinion gear 42. The pinion gear 42 drives a main gear 43 which is carried by the shaft 36 and rotates with the arm 35.

The clutch 40 is of a type well known in the art and includes a solenoid which, upon being energized, causes the clutch to be engaged for a single revolution of the shaft 44 and, upon completion of the revolution, is automatically disengaged and the shaft 45 is stopped. The gears 41, 42 and 43, which are shown only generally, are in such a ratio that, for each actuation of the clutch 40, the cutter head, e. g. the arm 35, is turned through a 90° arc. The arm 35 is normally held in a position parallel to the strip 26 so that upon a first actuation of the clutch 40, the arm will be rotated so as to bring one pair of cutters 37 and 38 into engagement with the strip 26. The arm remains in this position, and the cutters remove the corresponding portion of the edge of the strip until, upon a subsequent actuation of the clutch 40, the arm 36 is rotated through the succeeding 90° arc and the arm again aligned with the strip. Upon completion of this latter movement of the cutter arm, the remaining cutter head is in position for the start of the next succeeding cutting operation.

Referring again to Fig. 1, the electric circuit means 29 for operating the tear remover 28 comprises a wire recorder 50 which is driven by the motor 21 of the trimmer 13. The wire recorder 50 includes a continuous loop 51 of wire or other record medium, such as magnetic tape, which passes over a driving pulley 52 and an idler pulley 53. The drive pulley 52 is connected to the shaft 54 of the trimmer 13 by means of a suitable transmission or drive mechanism represented symbolically at 55. The recorder is driven from the trimmer 13 so that the wire 51 is driven at a speed closely corresponding to the speed of the strip 26 inasmuch as the speed of the feed mechanism 11 and the take-up mechanism 12 vary with the size of the coil carried by that mechanism. Other suitable arrangements may be utilized within the spirit of the invention.

The signals from the detector head 27 are amplified by means of an amplifier 56 and impressed upon the record wire 51 by means of a record coil 57 which is arranged to produce impressions upon the record wire during the forward travel of the loop, e. g. when the wire is traveling in the same direction as the strip 26. A plurality of pick-up coils including a holding coil 58, an advance coil 59 and a return coil 60 are successively positioned behind the record coil 57 along the forward path of the record wire 51. The pick-up coils 58, 59 and 60 control a holding circuit 61, a cutter advance circuit 62 and a cutter return circuit 63, respectively.

An erase coil 64 positioned along the return path of the recording medium 51 is energized by an erase circuit 65 and serves to erase the impressions produced upon the wire by the record coil 57, so that the wire is prepared to receive new signals upon a succeeding traverse through the recording and pick-up coils. The erase circuit 65 may constitute an oscillator or other circuit well known in the magnetic recording art.

The recorder 50 is driven at a speed which corresponds to the speed of the strip 26, that is, the portion of the wire 51 which carries an impression produced by the record coil 57 must traverse the distance to the advance coil 59 in the same interval of time as the associated flaw in the strip 26 requires to traverse the distance from the detector head 27 to the tear remover 28. Thus, the tape recorder may be driven at the same speed as the strip if the pick-up coils 57 and 60 are spaced the same distance apart as the detector head 27 and the tear remover 28. It is normally contemplated, however, that the distance between the recording coil 57 and the pick-up coil 60 will be some submultiple of the distance between the detector 27 and the tear remover 28, and the speed of the wire is some multiple of the speed of the strip. It is necessary, of course, that the pick-up coil 60 be positioned somewhat ahead of the above-referenced theoretical position because of the finite time required for the operation of the circuits and the cutter 28, so that the cutter 28 is in an operating position when the defect arrives at the cutter.

Referring now to Fig. 6, there is shown a schematic representation showing particularly the circuits of the electric circuit means 29 of Fig. 1, as well as the recorder 50, the detector head 27 and the detector amplifier 56. As there shown, the detector head 27 includes a lamp 70 which is adapted to illuminate one side of the strip 15. A photoelectric cell 71 on the opposite side of the strip is adapted to receive any light which is transmitted through cracks and tears in the strip and generates electrical signals in response thereto. The detector amplifier 56 is of known design and amplifies the signals received from the photoelectric cell 71 to produce the necessary magnetic field in the recording head 57 of the wire recorder 50. The signals which are impressed upon the wire 51 by the coil 57 are ordinarily impulsive in nature, but it is to be understood that the apparatus of the invention is peculiarly adapted to respond to continuing defects which extend for long distances along the edge of the strip.

The cutter 28 is actuated in response to the impressions which are formed upon the wire 51 by the recorder coil 57. To this end, a solenoid 72 of the clutch 40 is energized by a circuit, designated as the cutter advance circuit 62, which is, in turn, connected to the cutter advance pick-up coil 59 and is controlled by electrical signals generated in that coil in response to the recorded impressions formed by the recording coil 57.

The cutter advance circuit 62 includes an amplifier 73 comprising a triode 74, a clamper 75 comprising a diode 76 and a trigger generator 77 comprising two triodes 78 and 79, respectively. The anode of the triode

74 is energized from the positive lead 80 of a high voltage supply through a plate resistor 81 and the amplified impulses from the pick-up coil 59 transmitted to the control grid 82 of the trigger triode 79 by means of a coupling condenser 83. The clamper diode 76 has the cathode thereof connected to the control grid 82 and the coupling condenser 83 and the anode thereof connected to the grounded negative lead 84 of the high voltage supply so that only positively going impulses are impressed upon the control grid 82.

The trigger impulse generator 77 comprises the triodes 78 and 79 and serves to generate trigger impulses of predetermined length in response to arbitrary impulses derived from the pick-up coil 59. To this end, the anode 85 of the triode 78 is supplied with high voltage through a plate resistor 86 and is coupled to the control grid 87 of the triode 79 by means of a coupling condenser 88. The anode 89 of the triode 79 is supplied with high voltage through a plate resistor 90 and the grid 87 is connected to the high voltage lead by means of a grid dropping resistor 91. The triode 79 is normally in a conducting condition and the triode 78 is normally in a nonconducting condition so that, when a positive impulse is impressed upon the grid 82 of triode 78, the control grid 87 of triode 79 is driven negative, thereby causing the tube to become less conducting and increasing the potential at the anode 89. The voltage on the control grid 87 returns to the normal value after an interval determined solely by the time constant of the condenser 88 and the resistors 86 and 91 so that the duration of the positive impulse formed at the anode 89 may be controlled by adjusting the values of that condenser and the two resistors.

The cutter advance circuit 62 controls an energizing circuit 92 which includes a thyratron 93, a storage condenser 94 and a mechanically operated control switch 95. The circuit 92 serves to energize and deenergize the solenoid 72 in response to the positive impulses from the trigger generator 77.

The switch 95 comprises a cam member 96 having two diametrically opposed lobes 97 and 98 which open and close two switches 99 and 100. The cam 96 is carried by a shaft 101 which is mechanically coupled to the drive shaft 45 of the tear remover so that the cam 96 rotates in unison with the arm 35 of the cutter head. When the cutter head is in a disengaged position, e. g. so that the arm 35 is parallel with the strip, the switch 99 is closed and the switch 100 is opened, while; when the cutter head is engaged with the strip, e. g. the arm 35 is perpendicular to the strip, the switch 100 is closed and switch 99 opened.

The solenoid 72 of the tear remover clutch 40 is connected in series with the anode 102 of the thyratron 93 and to the positive lead 80 of the high voltage supply through an adjusting resistor 103. The condenser 94 is connected to the cathode 104 of the thyratron and to the arm of a potentiometer 105 in the negative lead 84 of the high voltage supply. In operation, the thyratron 93 is discharged by means of a positive impulse so that the condenser 94 is discharged into the solenoid 72, thereby energizing the solenoid and actuating the clutch. The solenoid 72 is energized for a period of time determined solely by the amount of charge carried by the condenser 94 which is, in turn, regulated by the variable resistor 103 and the potentiometer 105. This aspect of the invention constitutes an important and novel feature thereof inasmuch as it enables a precise control of a mechanical operation by means of an electrical impulse of relatively short duration.

The control grid 106 of the thyratron 93 is energized by the positive impulse from the trigger generator 77 which is transmitted to the grid through a coupling condenser 107, an isolating resistor 108 and the contacts 99 of the switch 95. A negative clamper comprising a diode 109 permits only positive impulses to be impressed upon the control grid 105 of the thyratron 93, whether transmitted through the switch contacts 99 or the switch contacts 100.

When the cutter head is in a disengaged position, an impulse from the pick-up coil 59 will cause the grid 106 of the thyratron 93 to be energized through the switch 99, thereby discharging the condenser 94 into the solenoid 72. The solenoid 72 is energized so that the clutch 40 will be operated to rotate the cutter head into engagement with the strip 15. It will be apparent that the energization of the solenoid 72 and the operation of the clutch 40 may be such that the cutter arm 35 will rotate through 180°, thereby removing an arcuate portion adjacent the edge of the strip containing the defect previously detected. Such an arrangement would constitute one embodiment of the invention.

It is often desirable, however, to hold the cutter head in engagement with the web so as to remove a succession of tears or other defects which are so closely spaced that removing one tear at a time would only increase the hazard of producing more tears. For this reason, it is contemplated that the cutter advance circuit will only cause the cutter bar 35 to be rotated through a 90° arc into engagement with the strip, and that separate cutter return and holding circuits 63 and 61, respectively, are provided for disengaging the cutter head by rotating the cutter arm 35 through the succeeding 90° after the lapse of a necessary interval of time.

The cutter return circuit 63 is connected to the cutter return pick-up coil 60 and impresses a positive impulse upon the control grid 106 of the thyratron 93 through the switch 100 to cause the solenoid 72 to be energized a second time and the cutter head withdrawn from engagement with the strip. To this end, the cutter return circuit 63 includes a first amplifier 110 comprising a triode 111, a second amplifier 112 comprising a triode 113, a clamper 114 comprising a diode 115 and a trigger impulse generator 116 comprising two triodes 117 and 118. The pick-up coil 60 is connected to the control grid 119 of the triode 111 so that the impulses generated in that coil as a result of the recorded impressions upon the wire 51 are amplified and impressed upon the control grid 120 of the triode 113 through a coupling condenser 121. The amplifier 112 incorporates a potentiometer 122 which is connected in the cathode circuit of the triode 113 so that the gain of the amplifier may be adjusted to the level necessary for proper operation of the generator 116. A coupling condenser 123 serves to impress the output of the amplifier 112 upon the control grid 124 of the triode 117. The diode 115 of the clamper 114 has the cathode thereof connected to the grid 124 and the coupling condenser 123 so that only positive going signals may be impressed upon the grid.

The trigger generator 116 is similar in all essential respects to the trigger generator 77 and serves to generate a positive impulse of predetermined duration in response to arbitrary impulses at the control grid 124 of the triode 117. The positive impulses are generated at the anode 125 of the triode 118 and are transmitted to the control grid 106 of the thyratron 93 through a coupling condenser 126, an isolating resistor 127 and the contacts 100 of the switch 95. The duration of the impulse is determined by the time constant of the circuit comprising resistors 128 and 129 and coupling condenser 130.

In operation, the contacts 100 of the switch 95 are closed by either of the lobes 98 or 97 of the cam 96 when the cutter head is in the engaged or 90° position. When the recorded impression which excited the pick-up coil 59, so as to cause the cutter head to become engaged with the strip, reaches the pick-up 60, the solenoid 72 is again energized and the cutter head is rotated through a succeeding 90° arc to remove the cutters from engagement with the strip.

If the above-described impression is followed by a suc-

cession of similar impressions such as might be produced by the coil 57 in response to a succession of defects in the strip, the cutter return circuit 63 is disabled by the holding circuit 61 so as to prevent the cutter head from being rotated through the second 90° arc until such time as the entire defective edge portion of the strip has been severed from the main portion thereof. To this end, the pick-up coil 58, which comprises a succession of separate short coils, is positioned ahead of the coil 59 and is connected to the holding circuit 61 to produce a succession of impulses at the input of that circuit when an impression passes through the coil. The holding circuit 61 includes an amplifier 135 which comprises a triode 136, a clamper 137 comprising a diode 138, and a blank impulse generator 139 which comprises two triodes 140 and 141. The electrical signals generated by the pick-up coil 58 are amplified by the triode 136 and impressed upon the control grid 142 of the triode 140. The clamper 137 comprises a diode 138 having the cathode thereof connected to the control grid 142 and to the coupling condenser 143 so that only positive going impulses are impressed upon the control grid. The arrangement of the blank impulse generator is such that the triode 140 is normally non-conducting and the positive impulses from the amplifier 135 cause the triode 140 to become more conducting and the triode 141 to become less conducting. When the triode 140 is made more conducting, the voltage at the anode 147 thereof is momentarily reduced and, by reason of the coupling condenser 149, the control grid of tube 141 is made more negative. As a result the tube 141 becomes less conducting and the voltage drop across the common cathode resistor is reduced so that the triode 140 is maintained in a more conducting state until such time as the condenser 149 discharges and the control grid of tube 141 becomes more positive. The tube 141 then becomes more and more conducting and the tube 140 becomes less conducting until the generator again reaches a stable state. The duration of the period in which the tube 140 is more conducting is thus determined by the effective constants of the circuit and particularly the time constant of the condenser 149 and the resistor 150. The generator includes an output circuit comprising a resistor 144 and a condenser 145 which are connected in series with the plate resistor 146 of the triode 140 and to the anode 147 thereof. When a positive impulse is impressed upon the control grid 142, the potential of the anode 147 is momentarily decreased, causing the condenser 145 to discharge, thereby reducing the voltage across the condenser to produce a negative impulse which is impressed upon the control grid 120 of the triode 113 through an isolating resistor 148. The magnitude of the negative impulse is such that the amplifier 112 is rendered inoperative and will not respond to signals from the pick-up coil 60. The duration of the impulse is determined by the relative size of the condenser 145 and resistors 144 and 146 in the plate circuit of the triode 140 as well as the relative size of the coupling condenser 149 and resistor 150 in the grid circuit of the triode 141.

In operation, the recorded impression which caused the cutter head to be advanced causes the cutter head to be returned unless, by reason of the presence of succeeding impressions in the pick-up coil 58, the amplifier 112 is disabled by the negative impulse from the trigger generator 139. If the amplifier 112 is so disabled during the passage of the original impression through the pick-up coil 60, the cutter return circuit 63 is subsequently energized and the cutter head returned when the succeeding impressions pass through the coil 60.

Referring now to Fig. 7, there is shown a schematic representation of a second embodiment of the invention in which the wire recorder is utilized to control a plurality of independent operations in a tube mill. The apparatus shown comprises one stage in the production of welded seam tubing from a flat strip and includes a welder 160 and a plurality of rolls 161, 162, 163 and 164 for carrying the welded tubing 165. A recorder 166, similar in all essential respects to the recorder 50 of Fig. 1, is driven from the rolls 161 by any suitable transmission means 167. A detector device 168 is positioned adjacent the tube line and functions to detect defects in the seam produced by the welder 160. The detector device 168 is electrically connected to a record coil 169 which functions to produce impressions upon the record wire 170 in response to the electrical impulses from the testing device 168.

A first pick-up coil 171 is positioned a suitable distance behind the record coil 169 and is connected to an electrical control circuit 172 which is, in turn, operatively connected to an induction heating unit 173 which is normally operative so as to heat and anneal the welded tubing. When the impression caused by a defect at the detector device 168 reaches the pick-up coil 171, the control circuit 172 deactuates the induction heater 173 so as to prevent the defective portion of the tube from being burned.

A second pick-up coil 174 is positioned behind the first pick-up coil 171 and is connected to a control circuit 175 which is, in turn, operatively connected to a cut-off machine 176. When the impression on the record wire produced by the defect reaches the second pick-up coil 174, the cut-off machine 176 is operated to sever that portion of the tubing.

A gating mechanism 177 for removing the defective portion of the tubing is operated by a control circuit 178 which may be connected to the control circuit 175, or, as shown in dotted outline, to a third pick-up coil 179.

Inasmuch as the operation of the tear removers 28 and 31 is, to a certain extent, dependent upon the speed of travel of the strip 15, means are provided in the embodiment of the invention of Fig. 1 for disabling the energizing circuit when the speed of the strip 15 exceeds or falls below predetermined speeds. A tachometer generator 180 is driven with the strip by a suitable transmission means 181 which may be connected to the trimmer drive with the wire recorder. The output of the tachometer generator is connected to a voltage sensitive relay 182 which, in turn, has the contacts thereof connected to the grid 106 of the thyratron 93. The relay arrangement is such that the relay contacts serve to ground the control grid 106 at all times, except when the strip is running within a predetermined range of speeds, whereupon the grid circuit is open and the grid 106 may be energized by the positive impulse from the trigger generator.

It is to be understood that the specific nature of the present disclosure is not intended to be restrictive or confining, but that various rearrangements of the apparatus be resorted to, giving effect to a reasonable breadth of construction of the express language of the claims, as hereinafter set forth.

What is claimed is:

1. Apparatus for continuously processing metallic strip which comprises, in combination, means for feeding the strip, means for taking up the strip, a photoelectric detector head mounted adjacent one edge of the strip for generating electrical signals in response to flaws in the strip; a recorder incorporating a continuous loop record medium and means for driving the recorder at a speed corresponding to that of the strip, a record coil for impressing the electrical signals from the detector head upon the record medium, a tear remover including a cutter and a solenoid clutch adapted to move the cutter into and out of engagement with the strip upon successive energizations of the solenoid thereof, a pick-up coil coupled to the said record medium and positioned behind the record coil a distance corresponding to the distance from the detector head to the tear remover, and electric circuit means connected to the said pick-up coil and to the solenoid of the clutch for actuating the clutch to move

the cutter into and out of engagement with the strip in response to the impressions upon the record medium produced by the record coil and thereby remove the edge portion of the strip containing the flaw detected by the detector head.

2. The invention in accordance with claim 1, said electric circuit means comprising means for generating a positive impulse of predetermined duration in response to signals from the pick-up coil and an energizing circuit comprising a thyratron and a storage capacitor connected in series with the solenoid of the clutch and a control grid in the thyratron connected to the said impulse generating means for discharging the storage capacitor into the solenoid in response to the impulse from the generator.

3. The invention in accordance with claim 2, said impulse generating means comprising an amplifier having the input thereof connected to the pick-up coil and the output connected to a multivibrator having a resistance condenser network for determining the duration of a second one of two conditions and a clamper connected to the said multivibrator at the input thereof for insuring response only to signals of a predetermined polarity.

4. The invention in accordance with claim 2 and including a means for charging the said storage condenser to a predetermined voltage comprising a variable resistor connected in series with the storage condenser and the charging means whereby the duration of energization of the solenoid is determined by the charge accumulated by the condenser.

5. Apparatus for continuously processing a continuous strip which comprises, in combination, means for feeding the strip, means for taking up the strip, detector means mounted adjacent the strip for generating electrical signals in response to flaws in the strip, a recorder incorporating a continuous loop recording medium, and means for driving the recorder at a speed corresponding to that of the strip, means for impressing electrical signals from the detector means upon the record medium, means for operating upon the strip spaced from the detector means and including means for actuating the operating means and means for deactuating the operating means, means coupled to the said record medium and connected to the actuating means for actuating the said operating means in response to impressions carried by the record medium, and a second succeeding means coupled to the record medium and connected to the said deactuating means for deactuating the said operating means in response to impressions which had earlier caused the operating means to engage the strip.

6. Apparatus for continuously processing metallic strip which comprises, in combination, means for feeding the strip, means for taking up the strip, a photoelectric detector head mounted adjacent an edge of the strip for generating electrical signals in response to flaws adjacent the edge of the strip, a wire recorder incorporating a continuous loop of wire and means for driving the recorder at a speed corresponding to that of the strip, means for impressing the electrical signals from the detector head upon the wire, a tear remover including a cutter wheel and a solenoid clutch adapted to move the cutter wheel into and out of engagement with the strip upon successive energizations thereof, means coupled to the said wire for actuating the clutch to move the cutter into engagement with the strip in response to impressions carried by the record wire and a second succeeding means coupled to the wire for subsequently actuating the clutch to remove the cutter from engagement with the strip.

7. Apparatus for continuously processing a metallic strip which comprises, in combination, means for feeding the strip, means for taking up the strip, means for trimming the edges of the strip, a photoelectric detector head mounted adjacent an edge of the strip for generating electrical signals in response to flaws adjacent the edge of the strip after trimming, a wire recorder incorporating a continuous loop of wire and means for driving the recorder from the trimmer so that the speed of the wire corresponds to the speed of the strip, means for impressing the electrical signals from the detector head upon the wire, a tear remover including a cutter wheel and a solenoid clutch adapted to move the cutter wheel into and out of engagement with the strip upon successive energizations thereof, means coupled to the said wire for actuating the clutch to move the cutter into engagement with the strip in response to impressions carried by the record wire and a second succeeding means coupled to the wire for subsequently actuating the clutch to remove the cutter from engagement with the strip in response to the same impressions.

8. Apparatus for continuously processing sheet strip which comprises, in combination, means for feeding the strip, means for taking up the strip, a photoelectric detector head mounted adjacent an edge of the strip for generating electrical signals in response to flaws in the strip, a recorder incorporating a continuous loop record medium and means for driving the recorder at a speed corresponding to that of the strip, a record coil for impressing the electrical signals from the detector head upon the record medium, a tear remover including a cutter wheel and a solenoid clutch adapted to move the cutter wheel into and out of engagement with the strip upon successive energizations of the solenoid thereof, a first pick-up coil coupled to the said record medium and positioned behind the record coil a distance corresponding to the distance from the detector head to the tear remover and a first electric circuit means connected to the said pick-up coil and to the solenoid clutch for actuating the clutch to move the cutter into engagement with the strip in response to signals generated in the pick-up coil by the impressions upon the record medium produced by the record coil, a second pick-up coil coupled to the said record medium and positioned behind the first pick-up coil and a second electric circuit means connected to the said second pick-up coil and to the solenoid of the clutch for actuating the clutch to move the cutter out of engagement with the strip in response to signals generated in the second pick-up coil by the impressions upon the record medium which cause the cutter to be moved into engagement.

9. The invention in accordance with claim 8, the said first electric circuit means comprising means for generating a positive impulse of predetermined duration in response to the signals from the first pick-up coil and the said second electric circuit means comprising means for generating a positive impulse of predetermined duration in response to signals from the second pick-up coil, an energizing circuit comprising a thyratron and a storage capacitor connected in series with the solenoid of the clutch and a rotary switch mechanically driven in unison with the cutter and having a first set of contacts connected between the first generating means and a control grid of the thyratron and closed only when the cutter is out of engagement with the strip, and a second set of contacts connected between the second electric circuit means and the control grid and closed only when the cutter is in engagement with the strip.

10. The invention in accordance with claim 9, said rotary switch comprising a cam having two opposed lobes and two sets of normally open contacts spaced 90° apart about the cam and the first one of the said switch contacts being normally engaged and closed by the said lobes when the cutter is out of engagement with the strip.

11. Apparatus for continuously processing sheet strip which comprises, in combination, means for feeding the strip, means for taking up the strip, a photoelectric detector head mounted adjacent an edge of the strip for generating electrical signals in response to flaws in the strip, a recorder incorporating a continuous loop record medium and means for driving the recorder at a speed corresponding to that of the strip, a record coil for im-

pressing the electrical signals from the detector head upon the record medium, a tear remover including a cutter wheel and a solenoid clutch adapted to move the cutter wheel into and out of engagement with the strip upon successive energizations of the solenoid thereof, a first pick-up coil coupled to the said record medium and positioned behind the record coil a distance corresponding to the distance from the detector head to the tear remover and a first electric circuit means connected to the said pick-up coil and to the solenoid clutch for actuating the clutch to move the cutter into engagement with the strip in response to signals generated in the pick-up coil by the impressions upon the record medium produced by the record coil, a second pick-up coil coupled to the said record medium and positioned behind the first pick-up coil and a second electric circuit means connected to the said second pick-up coil and to the solenoid of the clutch for actuating the clutch to move the cutter out of engagement with the strip in response to signals generated in the second pick-up coil by the impressions upon the record medium which cause the cutter to be moved into engagement, a third pick-up coil coupled to the said record medium and positioned ahead of the said second pick-up coil and a third electric circuit means connected to the said third pick-up coil and to the said second circuit means for disabling the said second circuit means so that the cutter is not moved out of engagement with the strip if the said impressions are followed by other impressions due to flaws in the succeeding portions of the strip.

12. The invention in accordance with claim 11, the said third circuit means comprising an amplifier having the input thereof connected to the third pick-up coil and a trigger impulse generator connected to the said amplifier and having the output thereof connected to the said second circuit means for impressing a disabling impulse upon a portion of that circuit.

13. Apparatus for processing welded seam tubing which comprises a plurality of rolls for carrying the tubing, a detector device positioned adjacent the tubing for generating electrical signals in response to flaws in the weld of the tubing, a recorder incorporating a continuous loop record medium and transmission means connected to a roll and to the recorder for driving the recorder at a speed corresponding to that of the tubing, a record coil for impressing electrical signals from the detector device upon the record medium, an induction heater positioned along the tube line behind the detector device, a pick-up coil coupled to the said record medium and positioned behind the record coil a distance corresponding to the distance from the detector device to the induction heater and a first electric circuit means

connected to the said pick-up coil and to the induction heater for deactuating the said heater in response to signals generated in the pick-up coil by the impressions upon the record medium produced by the record coil, a cut-off machine positioned along the tube line behind the induction heater, a second pick-up coil coupled to the said record medium and positioned behind the said first pick-up coil and a second electric circuit means connected to the said second pick-up coil and to the said cut-off machine for actuating the cut-off machine to sever defective portions of the tubing in response to signals generated in the second pick-up coil by the impressions upon the record medium which cause the induction heater to be deenergized.

14. Apparatus for processing metallic tubing comprising in combination a plurality of sets of rolls for feeding the tubing, a continuous loop of wire adapted to carry recorded signals, means for driving the wire loop at a speed corresponding to that of the speed of the tubing, a detector device mounted adjacent the line to observe the condition of the tubing, means for impressing electrical signals upon the wire of the loop, an electrical connection between the said impressing means and the testing device, an induction heating unit positioned adjacent the tubing line after the testing device for heating the tubing, a pick-up device coupled with the wire loop and positioned at a point after the said impressing means and electric means connected to the said pick-up and to the induction heating means for controlling the said heating means in response to impulses from the said wire loop, a cut-off device positioned adjacent the line at a station following that of the induction heating device, a second pick-up coupled to the wire loop at a point following the first-named pick-up and electric circuit means connected to the second pick-up and to the cut-off device for controlling the said cut-off device in response to the signals impressed upon the wire by the impressing means when that signal reaches the second pick-up whereby the heating and cut-off operations are conducted upon the moving tubing when the observed portion of the tubing passes those devices.

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