Dec. 15, 1959 J. C. LYTTLE 2,916,801

MACHINE CONTROL MEANS INCLUDING WORK FEED PROGRAMMING MEANS

Filed Sept. 19, 1957 2 Sheets-Sheet 1

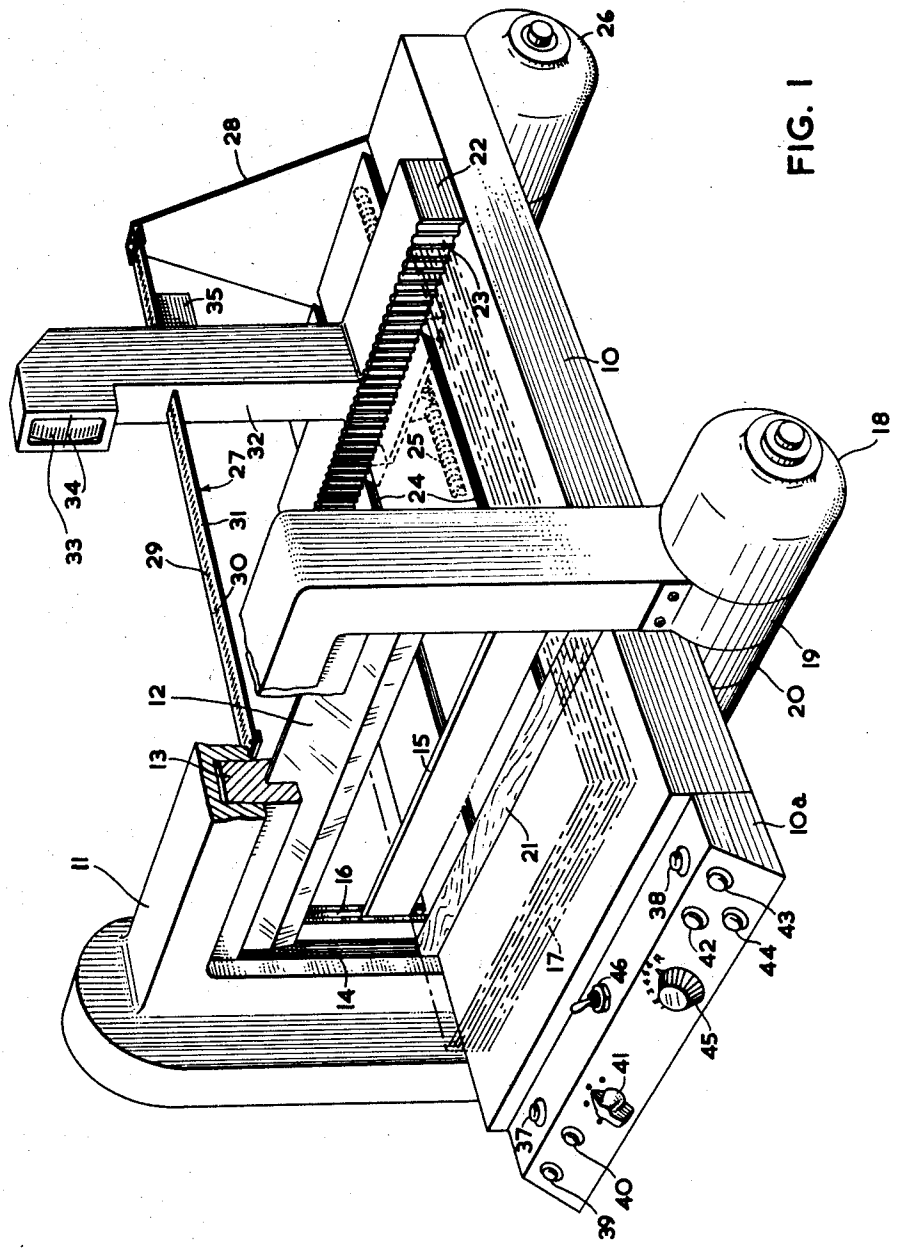


FIG. 1

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MACHINE CONTROL MEANS INCLUDING WORK FEED PROGRAMMING MEANS

Filed Sept. 19, 1957 2 Sheets-Sheet 2

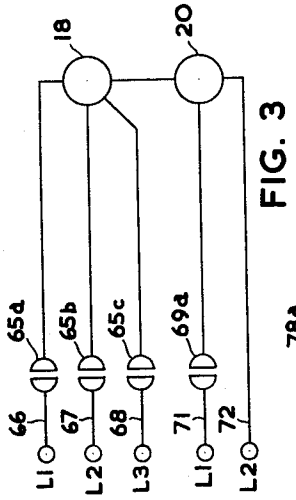


FIG. 3

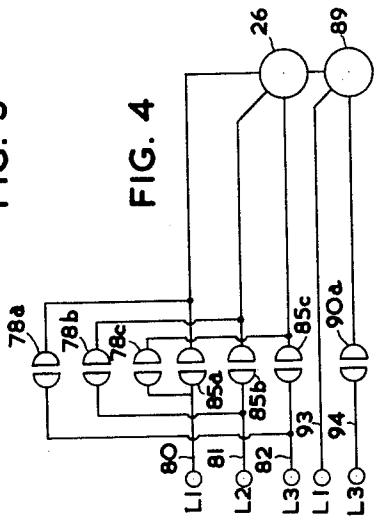


FIG. 4

FIG. 2

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2,916,801

MACHINE CONTROL MEANS INCLUDING WORK FEED PROGRAMMING MEANS

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Application September 19, 1957, Serial No. 685,032

10 Claims. (Cl. 29—93)

This invention relates to apparatus comprising two members and means to control the movement of one of the members relatively to the other member. The invention is particularly applicable to paper cutting machines in relation to which it will be specifically described, but the invention may also be applied to other apparatus in which two members are movable relatively to one another and it is desired to control the relative movements of the members in a predetermined manner.

Paper cutters as used in the printing trade include a table, a back gauge movable relatively to the table and a cutter blade to cut through a stack of paper supported upon the table against the back gauge. The back gauge is movable along the table by traversing means so as to be capable of positioning a stack of paper under the cutter blade. Such paper cutters are used to cut large sheets of paper into smaller sheets of specific sizes. Sometimes the large paper sheets are cut to a predetermined size and sometimes the cutting is effected along lines marked on the paper; in either case it is often necessary that the paper be cut to size within very close tolerances.

Various constructions for setting the position of back gauges on paper cutters are already known. In one known construction the back gauge is moved along the table by manually operated screw means and a graduated flexible metallic tape is connected to the back gauge and runs around fore and aft pulleys so that the position of the back gauge on the table may be read off the tape by the operator. After a period of use the tape may stretch and render the setting of the back gauge inaccurate so that cutting to close tolerances becomes impossible. Moreover foreign matter may accumulate on the pulleys, thus introducing errors, and the attachment of the tape to the back gauge may not remain rigid after prolonged use.

In another known construction for operating the back gauge, the gauge is moved by a flexible graduated tape, the tape itself providing the traction element. The disadvantages of this construction are the same as the disadvantages of the first construction, in addition the tape may slip and alter its position relative to the back gauge, thus introducing further inaccuracy.

Furthermore, it is sometimes required to set up a definite programme of movements to be followed by the back gauge. For example, it may be required that the cutter blade shall make a first cut with the back gauge three feet behind the cutter blade, a second cut when the back gauge is two feet behind the cutter blade and a third cut when the back gauge is one foot behind the cutter blade. Various methods of setting up such a programme mechanically are known.

For example, one method of mechanical setting employs a cam wheel having a circumferential graduated tape and stops which may be adjusted in position around the periphery of the wheel and which operate limit switches to start and stop an electric motor driving the traversing means of the back gauge. A very experienced operator is required to set up such an arrangement since there may be varying discrepancies between the scale on

the cam wheel and the scale against which the position of the back gauge is read. Moreover the physical difficulty of setting the stops accurately is considerable. Moreover, not only is an experienced operator required to set up such a machine, but the setting up time is considerable so that it is only economical when a large number of runs each requiring to be cut at the same positions is contemplated.

It has also been proposed to control the back gauge of a paper cutting machine by means of an optical system using a photo-electric cell and a strip bearing optical signals. A mechanical linkage is provided between the photo-electric cell and back gauge to effect traversing movement of the photo-electric cell across the strip in dependence on the movement of the back gauge. This mechanical linkage wears after a period of use and causes inaccuracies.

It will be appreciated that similar difficulties arise in automatic and semi-automatic machinery in which one member is moved relatively to another member along a predetermined path by traversing means and in which it is desired to cause the movable member to follow a particular sequence of movements relatively to the other member.

It has previously been proposed for machine tools to record a particular programme of events onto a magnetic tape and then to run the magnetic tape through a reproducing device to reproduce the events recorded on the tape in the machine tool. One disadvantage of such an arrangement is that relatively complicated means have to be provided for driving and reversing the tape. Another disadvantage is that, since the tape is not fixed relatively to any part of the tool, difficulties arise in synchronizing the programme on the tape with the positions of the parts of the machine tool. Moreover, once a programme has been recorded on the tape it is a comparatively lengthy operation to erase the programme and to record another programme and it is not possible, during the operation of the machine, easily to erase a single signal from the tape at a particular point and to substitute another signal.

It is an object of the present invention to provide apparatus having two members movable relatively to one another and means to traverse one of the members relatively to the other with a simple and versatile means for operating controls for the traversing means according to a predetermined but easily variable programme and in such a manner that mechanical linkages between the members and the means for operating the controls are reduced to a minimum to avoid inaccuracies due to mechanical wear.

It is also an object of the invention to provide a paper cutter having a table and a back gauge movable along the table, traversing means to move the back gauge and means to control the back gauge in its movements so that it may be caused to follow a predetermined programme which may be quickly changed or amended, the control means including a minimum of mechanical linkages to avoid inaccuracies consequent upon mechanical wear.

According to one aspect of the invention, apparatus comprises a first member, a guideway on the first member, a second member movable relatively to the first member in said guideway, a signal track of material capable of having electromagnetic signals erasably recorded thereon, the signal track extending longitudinally in a direction parallel to the direction of movement of the second member relatively to the first member and being mounted on the first member to be stationary relatively thereto, a support mounted on the second member, the support moving along a path adjacent to the signal track as the second member moves in the guideway, a recording and receiving head assembly mounted on the support, said assembly

being energizable to record electromagnetic signals on the track and being capable of receiving electromagnetic signals which may have been recorded on the track, means for energizing said assembly to record signals on the track, structure for traversing the second member along the guideway, controls to operate said structure, manually operable first means to operate the controls, second means operable in dependence on signals received by the recording and receiving head assembly from the signal track to operate the controls, and a selector operable to render one of said first and second means effective to operate the controls.

According to the second aspect of the invention, a paper cutter includes a table, a guideway on the table, a back gauge movable relatively to the table in said guideway, a signal track of material capable of having electromagnetic signals erasably recorded thereon, the signal track extending longitudinally in a direction parallel to the direction of movement of the back gauge relatively to the table and being mounted on the table to be stationary relatively thereto, a support mounted on the back gauge, the support moving along a path adjacent to the signal track as the back gauge moves in the guideway, a recording and receiving head assembly mounted on the support, said assembly being energizable to record electromagnetic signals on the track and being capable of receiving electromagnetic signals which may have been recorded on the track, means for energizing said assembly to record signals on the track, structure for traversing the back gauge along the guideway, controls to operate said structure, manually operable first means to operate the controls, second means operable in dependence on signals received by the receiving and recording head assembly from the signal track to operate the controls, and a selector operable to render one of said means effective to operate the controls.

The invention will be described by way of example with reference to the accompanying drawings in which:

Figure 1 is a diagrammatic perspective view of a paper cutter according to the invention, and

Figures 2, 3 and 4 are block diagrams showing the electric controls of the paper cutter of Figure 1.

Referring now to Figure 1, the paper cutter comprises a horizontal table **10** having a bridge structure **11** which carries a cutter blade **12**. The cutter blade is carried by a channel member **13** the ends of which slide in grooves **14** in the pillars of the bridge structure **11**.

A clamp **15** slides in grooves **16** in the bridge structure **11** and in Figure 1 is shown in its lower position where it grips a stack of paper **17** on the table **10**. Both the cutter blade **12** and the clamp **15** are operated by a motor **18** driving an eccentric gear **19** which is connected to the clamp **15** and to the channel member **13**. The motor **18** drives the eccentric gear **19** through an electromagnetic clutch **20**.

The eccentric gear **19** is so arranged that, upon rotation of the motor **18**, the clamp **15** descends to grip the paper on the table, then the cutter blade **12** descends to cut the paper, then the cutter blade rises and the clamp **15** rises and releases the paper. A wooden strip **21** is provided across the table **10** to act as a lower abutment for the cutter blade after it has cut through a stack of paper.

A back gauge is indicated at **22** and has a serrated forward surface **23**. The back gauge moves in guideways **24** in the table **10** and is threadably engaged by a lead screw **25** arranged under the table **10** and driven by a motor **26** through a clutch-brake (not shown in Figure 1). A horizontal bar **27** of non-magnetic material is supported at its forward end by the bridge member **11** and at its rear end by an abutment **28** fixed to the table. The bar **27** is provided with a longitudinal transparent graduated scale **29** and also with two magnetic tapes **30** and **31** on its underside, one on each side of the scale **29**.

The bar **27** is stationary relatively to the table **10**, that is to say, the bar does not move relatively to the table during normal operation of the machine although it may of course be unbolted from the machine and dismounted for disassembly or servicing purposes.

Upstanding from the top surface of the back gauge is a pillar **32** which is slotted to give passage to the bar **27** and is provided at its upper end with a translucent screen **33** having a cross-line **34**. An optical system (not shown) projects an image of the graduated scale **29** onto the screen **33** so that an operator standing at the front of the machine can read off the position of the back gauge, indicated by the cross-line **34**, on the image of the scale **29** on the screen **33**.

Mounted on the rear of the pillar **32** and beneath the bar **27** is a support **35** which carries seven combined recording and receiving heads, each head being capable of recording, receiving or erasing a signal on one of the tapes **30, 31**. The magnetic tapes **30, 31** provide seven signal tracks in all and each head is associated with and located under one of the signal tracks.

Manually operable means for controlling the machine are grouped on a control panel **10***a* at the front of the table **10** and consist of two pushbutton switches **37, 38** spaced at opposite ends of the control panel and arranged to operate the motor **18** as will be described more fully hereinafter. Push button **39** is a start button for the motor **18** and push button **40** is a stop button for the motor **18**. A first selector **41** has four positions which will be described more fully hereinafter, the positions being, "space," "off," "mark," and "erase."

A push button **42** controls the forward movement of the back gauge, that is towards the cutter blade, and a push button **43** controls the reverse movement of the back gauge. A push button **44** is provided for energizing an oscillator to record signals on the tapes **30, 31** and a second selector **45** is provided to select which of the seven heads shall be in circuit. A two-position switch **46** is also provided, in one of the positions of the switch **46**, the cutter blade is operated manually by the push buttons **37, 38**, and in the other position of the switch the cutter blade is operated in dependence on signals received from the tapes **30, 31**.

The controls of the paper cutter will now be described with reference to Figures 2, 3 and 4. The numeral **47** is used to designate a conventional tape recorder which includes the oscillator operated by the switch **44**, but does not include the normal tape transport mechanism. The output of the tape recorder is connected to a control contactor **48** having a pair of contacts **48***a* which are open when the contactor is de-energized and two pairs of contacts **48***b* and **48***c* which are closed when the contactor is de-energized. The output of the tape recorder **47** is connected to the control contactor **48** when the first selector **41**, is in its "space" position through a switch **41***c* forming part of the selector **41**, the switch **41***c* otherwise remaining open. When the selector **41** is in this position, the input to the tape recorder is from one of the heads carried by the support **35**, the particular head being selected by the second selector **45**. In Figure 2 the heads are indicated diagrammatically at **49, 50, 51, 52, 53, 54** and **55** and are connected by a cable **56** to the fixed contacts **49***a*, **50***a*, **51***a*, **52***a*, **53***a*, **54***a* and **55***a* respectively of the second selector **45**.

The heads are mounted on the support **35** so that each head underlies one of the seven signal tracks provided by the tapes **30, 31**. The heads are slidable relatively to the support **35** and are normally urged against stops **57, 58** by tension springs **59**. A solenoid **60** has its movable armature connected to the rearward end of the heads and is operable to draw the heads rearwardly against stops **61, 62**. When the solenoid is de-energized, the springs **59** pull the heads forwardly against the stops **57, 58**.

A line **63** leads through the switch **40**, the switch **39** and a contactor **65**. Power is applied to the motor **18** along lines **66, 67** and **68** through contacts **65***a*, **65***b* and

and 65c of the contactor 65. A fourth pair of contacts 65d of the contactor 65 is connected in parallel with the switch 39, the pair of contacts being normally in open position as shown. To start the main motor 18, the switch 39 is depressed thus allowing current to flow through the contactor 65. When the contactor 65 becomes energized, the pairs of contacts 65a, 65b, 65c and 65d close, thus starting the motor 18 and also, in the case of the contacts 65d, allowing current to continue to flow through the contactor 65 thereby holding the contactor energized and the motor on after the switch 39 has been released. To stop the motor 18, the switch 40 is depressed, thus opening the line 63, interrupting the current flowing through contactor 65 and therefore opening the pairs of contacts 65a, 65b, 65c and 65d.

The motor 18 drives the cutter blade 12 and the clamp 15 through the electromagnetic clutch 20 which is controlled by a contactor 69 having a pair of contacts 69a which are open when the contactor is de-energized. To energize the clutch 20, the switches 37, 38 have to be pressed simultaneously to allow current to flow along a line 70 through the contactor 69 which is thereby energized and closes the pair of contacts 69a thus allowing power to be fed to the clutch along lines 71 and 72. The contactor 69 will only be energized so long as both switches 37, 38 are held depressed and the switches are spaced apart on the control panel so that the operator will have to use both hands to press them both, thereby ensuring that as the cutter blade descends the operator's hands are not underneath it.

A line 73 is connected in parallel with the switches 37, 38 and is connected to the line 70 on the switch side of the contactor 69. In the line 73 is the switch 46, a pair of normally open contacts 48a of the control contactor 48, and a switch 41a forming part of the first selector 41 and which is open except when the selector 41 is in its "space" position. Also connected in parallel with the switches 37, 38 is a further line 74 containing a limit switch 75. The limit switch 75 is normally open but, as the cutter blade reaches a point near the bottom of its stroke it closes the limit switch 75 so allowing the switches 37, 38 to be released without de-energizing the contactor 69. The cutter blade and clamp will then return to their uppermost positions automatically. As the cutter blade approaches its uppermost position it will open the limit switch 75 thereby de-energizing the contactor 69 thus opening the pair of contacts 69a, de-energizing the clutch 20 and disconnecting the eccentric gear 19 from the motor 18.

The reverse motion of the back gauge is controlled by the switch 43. A line 76 leads through the switch 43, one part of a ganged switch 42, a limit switch 77 and a contactor 78. The contactor 78 has six pairs of contacts 78a, 78b, 78c, 78d, 78e and 78g, all of which are open when the contactor is de-energized, and a seventh pair of contacts 78f which are closed. A line 79 is connected in parallel with the switch 43 and contains the pair of contacts 78d and the pair of contacts 48b of the control contactor 48.

The part of the switch 42 that is in the line 76 is normally closed and to start the motor 26 in a reverse direction the switch 43 is closed allowing current to flow along the line 76 to energize the contactor 78 which will close the contacts 78a, 78b, 78c, 78d, 78e and 78g and will open the contacts 78f. The closing of the contacts 78a, 78b and 78c allows current to flow along the lines 80, 81 and 82 to the motor 26 which then rotates in a direction such as to move the back gauge away from the cutter blade. The pair of contacts 78d acts to maintain the current through the contactor 78 when switch 43 has been released and therefore to keep the back gauge motor running in the reverse direction.

The control for the back gauge motor in the forward direction is along a line 83 through the other part of the switch 42, a limit switch 84 and a contactor 85 having five sets of contacts 85a, 85b, 85c, 85d and 85e, all of which are in the open position when the contactor is de-energized. When the switch 42 is operated it closes the line 83 allowing current to flow through the limit switch 84 and the contactor 85 thus closing the pairs of contacts 85a, 85b, 85c, 85d and 85e. The contacts 85a, 85b and 85c when closed permit current to flow along the lines 80, 81 and 82 to the motor 26. It will be seen from Figure 4 that the arrangement of the contacts 78a, 78b, 78c, 85a, 85b and 85c is such that when the contactor 78 is energized the phase sequence of the lines 80, 81 and 82 is reversed relatively to the motor 26 compared with the phase sequence of the lines when the contactor 85 is energized. This arrangement allows the motor 26 to be rotated in either direction, the direction depending upon which set of contacts is closed.

It will be noted that as the switch 42 is operated it opens the line 76 thereby ensuring that the motor 26 shall not be energized to move in a reverse direction and a forward direction at the same time. The pair of contacts 85d is in a line 86 which also contains the pair of contacts 48c of the control contactor 48 and a switch 41b which forms part of the first selector 41. The switch 41b is open except when the selector 41 is in the "space" position and thus the contacts 85d, which operate to hold the contactor 85 energized, will only operate when the selector 41 is in the "space" position.

The limit switch 77 is a reverse limit switch which opens the line 76 when the back gauge reaches the end of its travel in a rearward direction. The limit switch 84 is a forward limit switch and opens the line 83 when the back gauge reaches the limit of its forward travel. In both cases opening of the limit switch prevents the back gauge from moving further since the relevant contactor 78 or 85 is de-energized and the power supply to the motor 26 is cut off. A further limit switch 87 is located in a line 88 and is connected in parallel with the pair of contacts 85d. The limit switch 87 is momentarily closed and then reopened by the cutter blade as it approaches the top of its travel after having descended to cut through a stack of paper.

The motor 26 operates the back gauge through an electromagnetic clutch-brake 89 connected to the lead screw 25. In its deenergized position the clutch-brake 89 acts as a brake and prevents the back gauge from moving. When the clutch-brake is energized it acts as a clutch transmitting rotation of the motor 26 to the lead screw 25 and hence to the back gauge 22. The clutch-brake 89 is controlled by a contactor 90 which is in a line 91. Also in the line 91 is the pair of contacts 85e of the contactor 85 which are connected in parallel with the pair of contacts 78e in a line 92. The contactor 90 has a pair of contacts 90a in the line 94 of two lines 93, 94 which are connected to the clutch-brake 89. When either of the contactors 78 or 85 is energized the contacts 78e or 85e will close thus energizing the contactor 90, closing the contacts 90a thus energizing the clutch-brake 89 and allowing the rotation of the motor 26 to be transmitted to the back gauge.

The solenoid 60 is operated by closing the switch 44 thus allowing current to flow along a line 95 and energize a contactor 96 having a pair of contacts 96a. The contacts 96a are in a line 97 of two lines 97, 98 leading to the solenoid and as the contacts are closed, the solenoid 60 is energized and moves the heads 49 to 55 rearwardly against the stops 61 and 62.

When the first selector 41 is in the "space" position the switches 41a, 41b and 41c are closed, the output of the tape recorder 47 is connected to the control contactor 48 and the heads 49 to 55 are connected through the second selector 45 and the contacts 78f or 78g to the input of the tape recorder 47 so that a signal received from a head will be amplified by the tape recorder 47 and will energize the control contactor 48. Between the movable terminal of the second selector 45 and the tape recorder 47 is the pair of contacts 78f of the contactor 78, the contacts

being in a closed position when the contactor is de-energized. Connected to the fixed terminal 55*a* of the second selector 45 is the pair of contacts 78*g* of the contactor 78 which are open when the contactor is deenergized. The pair of contacts 78*g* is in parallel with the contacts 78*f* so that when the contacts 78*f* are closed the input to the tape recorder 47 is through the movable part of the selector 45 whereas when the contacts 78*g* are closed the contacts 78*f* will be opened and the input to the tape recorder is through the pair of contacts 78*g*.

When the first selector 41 is in one of the "off," "mark" or "erase" positions the switches 41*a*, 41*b* and 41*c* are open as shown in Figure 2. In the "off" position the tape recorder 47 is not operative. In the "mark" position, operation of the switch 44 besides operating the solenoid 60, also, after a delay to enable the solenoid to move the heads, operates the oscillator in the tape recorder 47. The signal from the oscillator is fed into the head which is connected to the tape recorder, either through the movable arm of the selector 45 or through the pair of contacts 78*g*. In the "erase" position, the oscillator in the tape recorder is energized to produce an erase signal which is continuously fed out to the particular head which is connected to the tape recorder via the movable arm of the selector 45 or the pair of contacts 78*g*.

The terminals of a three phase power supply are indicated at L1, L2 and L3. As shown in Figure 2, one end of each of the lines 63, 70, 73, 74, 76, 79, 83, 86, 88, 91, 92 and 95 is connected to L1 as is one side of the power input for the tape recorder 47. The other ends of the lines 63, 70, 73, 74, 76, 79, 83, 86, 88, 91, 92 and 95 are connected to the line L2 as is the other side of the power input for the tape recorder 47. A return line 99 for the heads 49, 50, 51, 52, 53, 54 and 55 also is connected to L2, as shown in Figure 2.

The lines 66, 71, 80, 93 and 97 are connected to L1, while the lines 67 and 81 are connected to L2. The lines 68, 72, 82, 94 and 98 are connected to L3.

The operation of the paper cutter is as follows. Let it be assumed that there are no signals on the tapes 30, 31, that the back gauge is at the rear extremity of its travel and that the controls are in the positions shown in Figures 2, 3 and 4. It is now desired to set up a cutting programme for the back gauge whereby once the programme has been set up the back gauge may be started to move forward and will thereafter cut at predetermined points until it reaches the front extremity of its travel.

To set up the programme the first selector 41 is switched to the "mark" position. The switch 42 is depressed, current is fed along the line 83 to energize the contactor 85 and to close the five sets of contacts 85*a*, 85*b*, 85*c*, 85*d* and 85*e*. The contacts 85*a*, 85*b* and 85*c* upon closing will supply power to the motor 26 which will begin to rotate. As the pair of contacts 85*e* closes the contactor 90 will be energized thereby closing the pair of contacts 90*a* and energizing the electromagnetic clutch-brake 89. The clutch-brake then acts as a clutch and transmits the rotation of the motor 26 to the back gauge. Since the first selector 41 is in the "mark" position, the switch 41*b* will be open and therefore the contacts 85*d* will be non-operative to hold the contactor 85 energized. When the back gauge approaches the desired position, as indicated by the reading of the cross-line 34 against the projection of the scale 29 on the screen 33, the switch 42 is released. The back gauge then comes to rest since the contactor 85 is de-energized thereby opening all the contacts 85*a*, 85*b*, 85*c*, 85*d* and 85*e*, stopping the motor 26 and de-energizing the contactor 90 and hence the electromagnetic clutch-brake 89 which then acts as a brake and brings the back gauge to a standstill.

To record a mark on one of the tapes 30, 31, the switch 44 is depressed thus energizing the contactor 96, closing the contacts 96*a*, operating the solenoid 60 to draw the heads rearwardly and then causing the oscillator in the tape recorder 47 to generate a signal which is passed through the second selector 45 to the particular head connected by the selector to the tape recorder. It will be appreciated that any of the heads 49 to 55 and therefore any one of the seven signal tracks may be selected by the selector 45 to have a signal recorder thereon. As will be seen hereafter, only the head 55 is in circuit to feed into the tape recorder when the contactor 78 is energized, although the head 55 may be connected to the oscillator through the selector 45 in the same manner as the other heads and without the contactor 78 being energized.

The switch 42 is then depressed to start the back gauge moving forward again and is released when it is desired to record another signal on the tape. The sequence is repeated until all the desired signals have been set up on the tape by which time the back gauge will be near to the front of its travel. To cause the back gauge to return to the rear of the table, the switch 43 is depressed thus energizing the contactor 78 and closing all the pairs of contacts of that contactor. Closure of the pair of contacts 78*d* will hold the contactor 78 energized and closure of the pairs of contacts 78*a*, 78*b* and 78*c* will cause the motor 26 to rotate in the reverse direction. Closure of the pair of contacts 78*e* energizes the contactor 90 thus closing the pair of contacts 90*a* and energizing the electromagnetic clutch-brake 89 so that it acts as a clutch. The pair of contacts 78*f* will open, thus disconnecting the movable member of the second selector 45 from the tape recorder, and the pair of contacts 78*g* will close thus connecting the head 55 to the tape recorder.

If it is desired to record signals on a signal track so that the back gauge will stop at a desired position when reversing, the switch 42 is depressed momentarily at the desired spot thus breaking the circuit through the contactor 78 and opening all the contacts associated therewith. The second selector is then operated so that its movable arm is against the contact 55*a*. Depression of the switch 44 will then energize the contactor 96, close the pair of contacts 96*a* to energize the solenoid 60 which will move the heads rearwardly against the stops 61 and 62, after the solenoid has operated, the oscillator in the tape recorder 47 provides a signal which is fed out through the closed contacts 78*f* and the contact 55*a* to the head 55 and will record a signal on the signal track associated with the head.

The back gauge is restarted in its rearward movement by pressing the switch 43 and the marking sequence is repeated until all the desired marks have been recorded upon the track associated with the head 55. When the back gauge reaches the rearmost extremity of its travel it will open the limit switch 77 and thus de-energize the contactor 78 bringing the back gauge to a stop.

The back gauge may now be started forwardly by depressing the switch 42. If it is desired to make use of the programme which has been recorded on to the tape, the first selector 41 is switched to its "space" position which closes the switches 41*a*, 41*b* and 41*c*. As the switch 42 is depressed, the contactor 85 will be energized thus closing all the pairs of contacts associated therewith. The pair of contacts 85*d* when closed will act to hold the contactor 85 energized since current is passed along the line 86, through the pair of contacts 85*d*, the closed pair of contacts 48*c* and the switch 41*b* to the contactor 85.

When the head connected to the tape recorder by the second selector 45 picks up a signal from its associated signal track it will feed the signal into the tape recorder which will amplify it and pass it through the closed switch 41*c* to the control contactor 48. As the contactor 48 is energized the contacts 48*a* are closed and the contacts 48*b* and 48*c* are opened. The effect of opening the contact 48*c* is to interrupt the power through the contactor 85 thereby opening all the sets of contacts associated therewith. The opening of the contacts 85*a*,

85*b* and 85*c* interrupts the power to the motor **26**. The opening of the contacts **85***e* interrupts the power to the clutch-brake **89** thus bringing the back gauge to a halt.

The paper on the table may then be cut by depressing the switches **37**, **38**, thus energizing the contactor **69**, closing the contacts **69***a* and thus energizing the clutch **20** to cause the cutter blade **12** and clamp **15** to move through the cycle of clamping the paper on the table, cutting the paper and then releasing the clamp. As described above, when the cutter blade reaches the bottom of its stroke, the limit switch **75** is closed allowing the cutter blade to complete its stroke although the push buttons **37**, **38** are released. The control contactor **48** is such that after it has been energized it will maintain the contacts **48***a* closed and the contacts **48***b* and **48***c* open long enough for the cutter blade to reach the bottom of its stroke, thus closing the limit switch **75** and completing the remainder of the cutting cycle. The relay will then become de-energized opening the contacts **48***a* and closing the contacts **48***b* and **48***c*.

As the cutter blade approaches the top of its stroke after cutting the paper the limit switch **75** is opened and the motion of the cutter blade ceases. At about the same time as the limit switch **75** is opened the limit switch **87** is closed long enough for the contactor **85** to be energized and locked by the closing of the contacts **85***d*. As the contactor **85** is energized, the back gauge will start and will continue to move forward until a further signal is received by the head which is connected to the tape recorder through the second selector **45**.

If the switch **46** is closed, the cutter blade and clamp will be caused to operate automatically as the back gauge comes to a standstill as the result of a signal from a tape. Thus, when a signal is received by the control contactor **48**, the pair of contacts **48***a* which are normally open will close, and the contactor **69** will be energized along the line **73** through the switch **46**, the pair of contacts **48***a* and the switch **41***a*. The cutter blade and clamp will then proceed through their cycle until the limit switch **75** is operated. The contacts **48***a* will then open near to the end of the cycle and the limit switch **87** will close momentarily and cause the back gauge to start on its forward travel. When a further signal is received by the control contactor **48** the same sequence of operations will be repeated.

If it is desired to reverse the back gauge so that it will stop when signals are received from the track associated with the head **55**, the reverse button **43** is pressed with the first selector **41** still in the "space" position. As the switch **43** is pressed current is fed along the line **76** to energize the contactor **78** thus closing the contacts **78***a*, **78***b*, **78***c*, **78***d*, **78***e* and **78***g* and opening the contact **78***f*. The motor **26** will then begin to drive the back gauge in the reverse direction until a signal picked up by the head **55** is fed through the contacts **78***g* to the tape recorder **47**. The signal will then energize the control contactor **48** and open the contacts **48***b* thus breaking the circuit through the contactor **78** and bringing the back gauge to a stop. Either of the switches **42** or **43** may then be pressed to move the back gauge.

The normal positions of the heads **49**, **50**, **51**, **52**, **53**, **54** and **55** are those shown in Figure 2, i.e., spring urged against the stops **57**, **58** in a forward position i.e. towards the cutter blade. This is the position occupied by the heads when the paper cutter is on automatic operation, signals picked up from the heads being relayed to the control contactor **48** through the tape recorder **47**. When a programme is being recorded on the tapes **30**, **31**, every time the switch **44** is depressed the solenoid **60** is energized thus moving the heads to a rearward position against the stops **61**, **62**. It is in this rearward position that signals are recorded upon the tape. It will be seen therefore that the signal is recorded at a point on the tape which is to the rear of the actual point at which it is desired that the back gauge should stop. When a head picks up a signal it is passed through the tape recorder **47** to the contactor **48** which responds so that the back gauge is brought to a halt, this operation takes an appreciable, although short, length of time. The distance between the signal and the desired stopping point of the back gauge is adjusted so that in the time taken to bring the back gauge to a halt the back gauge has covered this distance and comes to a stop at the desired position.

It will be appreciated that a programme for the forward movement of the back gauge may be set up on each of the six signal tracks associated with the heads **49** to **54**, and that the desired programme may be selected by means of a second selector **45**. When it is desired to erase a programme from one of the signal tracks, the corresponding head is selected by the second selector **45**, the first selector **41** is turned to the "erase" position and the back gauge moved along its guideway. In the "erase" position the tape recorder feeds an erase signal out through the second selector **45** to the head which has been selected and erases a signal or all the signals on the associated track. In order to be able to erase a signal, or all the signals, on any of the tracks associated with the heads **49** to **54** it is necessary that the contactor **78** be de-energized so that the pair of contacts **78***f* are closed and the required head may be selected by the selector **45**. It follows that if all the signals on a track are to be erased, the back gauge must be moving in a forward direction, otherwise the contactor **78** will be energized. To amend the signals on a track the back gauge may be moved forwardly over just that portion of the track concerned. If desired the back gauge could be brought to a stop over the signal it is desired to erase and the signal then erased. It will be seen that any one signal may be erased and replaced by a signal in a different position. If all the signals on a track have been erased a new programme may then be set up in the manner described above.

The same procedure may be used to erase signals marked on the track corresponding to the head **55**, i.e., the track which provides the stopping signal for the back gauge during its reverse motion, although if all the signals are to be erased this can be done with the contactor **78** energized and the contacts **78***g* closed. The settings on the track associated with the head **55** will only be approximate due to the fact that the time taken for the back gauge to come to a standstill plus the distance the head was moved by the solenoid during recording will be cumulative when the back gauge is in reverse instead of cancelling out as they do when the back gauge is moving forwards. If it is only desired to make one cut which is, say, one foot away from the cutter blade, then after each cut it would be a waste of time to send the back gauge to the reverse limit of its travel and then advance it to a position one foot away from the cutter blade. In this case a signal is recorded on the track associated with the head **55** at, say, one foot six inches away from the cutter. The back gauge will stop near this position and then may be started on its forward travel and will only have to advance, say, six inches before it is stopped. This procedure saves the time which would be required for the back gauge to travel to and fro along the whole length of its path between cuts.

When the first selector **41** is in the "off" position the tape recorder **47** and the control relay **48** are non-operative, the paper cutter being operable only by the manual switches **37**, **38**, **39**, **40**, **42** and **43** the functions of which have been described above.

Although the invention has been described with reference to a paper cutter using seven combined recording and receiving heads, any convenient number of heads may be used. Also if desired separate heads may be used for recording and receiving, e.g., seven heads may be used for recording and another seven heads for receiving. When separate sets of heads are used the recording

heads will be disposed rearwardly of the receiving heads and it will be unnecessary to provide a solenoid to move either set of heads since they will be permanently in the correct positions for recording and receiving.

It will be seen that the invention provides a simple and versatile means for controlling the back gauge of a paper cutter in a desired sequence of movements. The whole length of each of the tapes providing the signal tracks is always available for the recording or erasure of signals and is stationary relatively to the table so that no misalignment can occur and give rise to inaccuracies.

It will be seen that there are no mechanical linkages to go wrong, the only movement of the signalling parts being the movement of the heads on the support **35**. This can be the only mechanical source of error in the setting up of a programme on the tape and this error may be reduced to a minimum by careful design of the device for moving the heads. The heads are either spring urged against stops **57**, and **58** which may be adjustable or urged by the solenoid against stops **61** and **62**, which may also be adjustable. The stops **57**, **58**, **61** and **62**, are adjustably secured to the support **35** and may be accurately postioned. The invention is very simple and its mechanical concept and the components of the electronic system associated with the machine are conventional and easily serviced.

It will also be appreciated that the invention is applicable to apparatus other than paper cutters wherein one member is movable relatively to the other and it is desired to control the movements of the members by means of erasable signals and without introducing mechanical linkages which, when worn, will cause inaccuracies, and which are subject to the accumulation of foreign matter and slippage.

It will be understood that the form of the invention herewith shown and described is a preferred example and various modifications can be carried out without departing from the spirit of the invention or the scope of the appended claims.

What I claim as my invention is:

1. Apparatus comprising a first member, a guideway on the first member, a second member movable relatively to the first member in said guideway, a signal track of material capable of having electromagnetic signals erasably recorded thereon, the signal track extending longitudinally in a direction parallel to the direction of movement of the second member relatively to the first member and being mounted on the first member to be stationary relatively thereto, a support mounted on the second member, the support moving along a path adjacent to the signal track as the second member moves in the guideway, a recording and receiving head assembly mounted on the support, said assembly being energizable to record electromagnetic signals on the track and being capable of receiving electromagnetic signals recorded on the track, means for energizing said assembly to record signals on the track, structure for traversing the second member along the guideway, controls to operate said structure, manually operable first means to operate the controls, second means operable in dependence on signals received by the recording and receiving head assembly from the signal track to operate the controls, and a selector operable to render one of said first and second means effective to operate the controls.

2. Apparatus comprising a first member, a guideway in the first member, a second member movable relatively to the first member in said guideway, a signal track of material capable of having electromagnetic signals erasably recorded thereon, the signal track extending longitudinally in a direction parallel to the direction of movement of the second member relatively to the first member and being mounted on the first member to be stationary relatively thereto, a support mounted on the second member, the support moving along a path adjacent to the signal track as the second member moves in the guideway, a recording and receiving head assembly mounted on the support, said assembly being energizable to record electromagnetic signals on the track and being capable of receiving electromagnetic signals recorded on the track, means for energizing said assembly to record signals on the track, spring means normally urging said assembly to a first position on the support, shifting means operable to move said assembly on said support to a second position, said shifting means being operable in conjunction with said means for energising the assembly, structure for traversing the second member along the guideway, controls to operate said structure, manually operable first means to operate the controls, second means operable in dependence on signals received by the recording and receiving head assembly from the signal track to operate the controls, and a selector operable to render one of said first and second means effective to operate the controls.

3. Apparatus comprising a first member, a guideway on the first member, a second member movable relatively to the first member in said guideway, a plurality of parallel signal tracks of material capable of having electromagnetic signals erasably recorded thereon, the signal tracks extending longitudinally in a direction parallel to the direction of movement of the second member relatively to the first member and being mounted on the first member to be stationary relatively thereto, a support mounted on the second member and arranged to move along a path adjacent to the tracks as the second member moves in the guideway, a plurality of receiving heads mounted on the support, each head being associated with a different track to receive electromagnetic signals recorded on the track, a plurality of recording heads mounted on the support, each recording head being associated with a different track and energizable to record electromagnetic signals on the track, means for energizing said recording heads to record signals on the tracks, structure for traversing the second member along the guideway, controls to operate said structure, manually operable first means to operate the controls, second means operable in dependence on signals received from one of the receiving heads to operate the controls, a first selector operable to render one of said first and second means effective to operate the controls and a second selector operable to connect a desired receiving read to the second means.

4. Apparatus comprising a first member, a guideway on the first member, a second member movable relatively to the first member in said guideway, a plurality of parallel signal tracks of material capable of having electromagnetic signals erasably recorded thereon, the signal tracks extending longitudinaly in a direction parallel to the direction of movement of the second member relatively to the first member and being mounted on the first member to be stationary relatively thereto, a support mounted on the second member and arranged to move along a path adjacent to the tracks as the second member moves in the guideway, a plurality of combined receiving and recording heads mounted on the support, each head being associated with a different track and being energizable to record electromagnetic signals on the track and being capable of receiving electromagnetic signals recorded on the track, means for energizing said heads to record signals on said tracks, structure for traversing the second member along the guideway, controls to operate said structure, manually operable first means to operate the controls, second means operable in dependence on signals received from one of the combined receiving and recording heads to operate the controls, a first selector operable to render one of said means effective to operate the controls, and a second selector operable to connect a desired combined receiving and recording head to the second means.

5. Apparatus as claimed in claim 4, including spring means normally urging said combined receiving and recording heads to first positions on the support, and shifting means operable to move said heads to second positions on the support, said shifting means being operable in conjunction with said means for energizing the heads to record signals on the tracks.

6. A paper cutter including a table, a guideway on the table, a back gauge movable relatively to the table in said guideway, a signal track of material capable of having electromagnetic signals erasably recorded thereon, the signal track extending longitudinally in a direction parallel to the direction of movement of the back gauge relatively to the table and being mounted on the table to be stationary relatively thereto, a support mounted on the back gauge, the support moving along a path adjacent to the signal track as the back gauge moves in the guideway, a recording and receiving head assembly mounted on the support, said assembly being energizable to record electromagnetic signals on the track and being capable of receiving electromagnetic signals recorded on the track, means for energizing said assembly to record signals on the track, structure for traversing the back gauge along the guideway, controls to operate said structure, manually operable first means to operate the controls, second means operable in dependence on signals received by the receiving and recording head assembly from the signal track to operate the controls, and a selector operable to render one of said means effective to operate the controls.

7. A paper cutter including a table, a guideway on the table, a back gauge movable relatively to the table in said guideway, a signal track of material capable of having electromagnetic signals erasably recorded thereon, the signal track extending longitudinally in a direction parallel to the direction of movement of the back gauge relatively to the table and being mounted on the table to be stationary relatively thereto, a support mounted on the back gauge, the support moving along a path adjacent to the signal track as the back gauge moves in the guideway, a recording and receiving head assembly mounted on the support, said assembly being energizable to record electromagnetic signals on the track and being capable of receiving electromagnetic signals recorded on the track, means for energizing said assembly to record signals on the track, spring means normally urging said assembly to a first position on said support, shifting means to move said assembly on said support to a second position against said spring means, said shifting means being operable in conjunction with said means for energizing said assembly, structure for traversing the back gauge along the guideway, controls to operate said structure, manually operable first means to operate the controls, second means operable in dependence on signals received by the recording and receiving head assembly from the signal track to operate the controls, and a selector operable to render one of said first and second means effective to operate the controls.

8. A paper cutter including a table, a guideway on the table, a back gauge movable relatively to the table in said guideway, a plurality of parallel signal tracks of material capable of having electromagnetic signals erasably recorded thereon, the signal tracks extending longitudinally in a direction parallel to the direction of movement of the back gauge relatively to the table and being mounted on the table to be stationary relatively thereto, a support mounted on the back gauge and arranged to move along a path adjacent to the tracks as the back gauge moves in the guideway, a plurality of receiving heads mounted on the support, each head being associated with a different track to receive electromagnetic signals recorded on the track, a plurality of recording heads mounted on the support, each recording head being associated with a different track and energizable to record electromagnetic signals on the track, means to energize said recording heads to record signals on the tracks, structure for traversing the back gauge along the guideway, controls to operate said structure, manually operable first means to operate the controls, second means operable in dependence on signals received from one of the receiving heads to operate the controls, a first selector operable to render one of said means effective to operate the controls, and a second selector operable to connect a desired receiving head to the second means.

9. A paper cutter including a table, a guideway on the table, a back gauge movable relatively to the table in said guideway, a plurality of parallel signal tracks of material capable of having electromagnetic signals erasably recorded thereon, the signal tracks extending longitudinally in a direction parallel to the direction of movement of the back gauge relatively to the table and being mounted on the table to be stationary relatively thereto, a support mounted on the back gauge and arranged to move along a path adjacent to the tracks as the back gauge moves in the guideway, a plurality of combined receiving and recording heads mounted on the support, each head being associated with a different track to receive electromagnetic signals recorded on the track and energizable to record electromagnetic signals on the track, means to energize said heads to record signals on the tracks, structure for traversing the back gauge along the guideway, controls to operate said structure, manually operable first means to operate the controls, second means operable in dependence on signals received from one of the combined receiving and recording heads to operate the controls, a first selector operable to render one of said first and second means effective to operate the controls, and a second selector operable to connect a desired combined receiving and recording head to the second means.

10. A paper cutter as claimed in claim 9, including spring means normally urging said combined receiving and recording heads to first positions on the support, and shifting means operable to move said heads to second positions on the support, said shifting means being operable in conjunction with said means for energizing the heads to record signals on the tracks.

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