

March 10, 1964

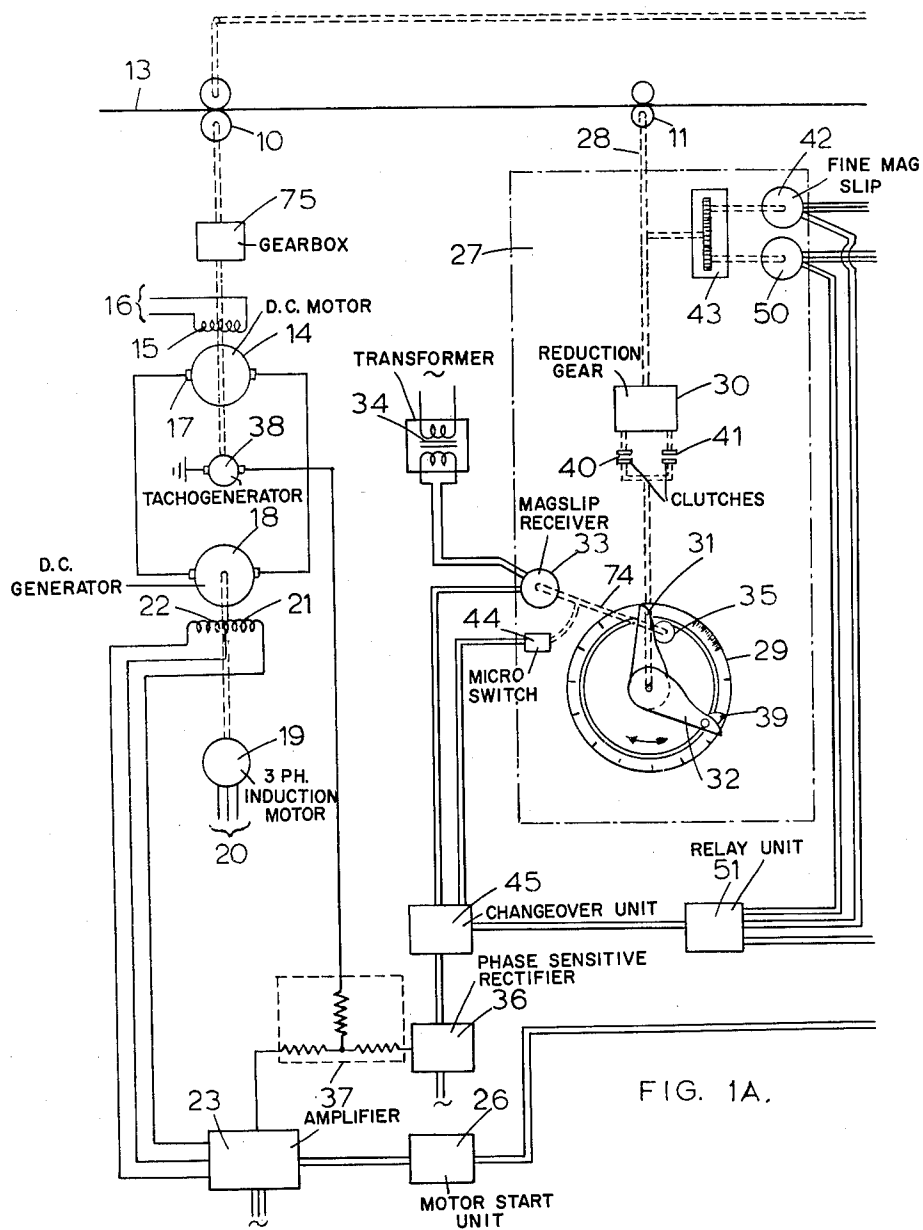
R. J. LLOYD

3,124,290

MACHINES FOR AUTOMATICALLY FEEDING STRIP MATERIAL

Filed Oct. 18, 1961

2 Sheets-Sheet 1



INVENTOR
 Raymond Joseph Lloyd
 By Alexander D. Dell
 attorney

March 10, 1964

R. J. LLOYD

3,124,290

MACHINES FOR AUTOMATICALLY FEEDING STRIP MATERIAL

Filed Oct. 18, 1961

2 Sheets-Sheet 2

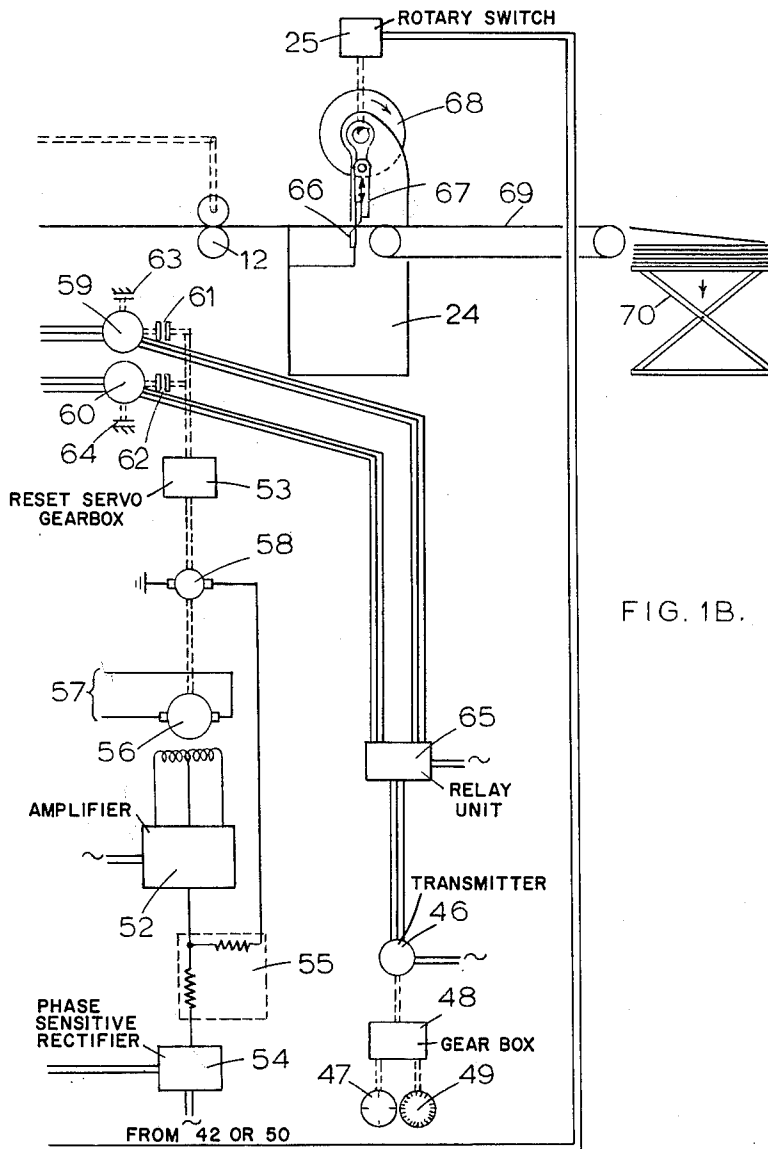


FIG. 1B.

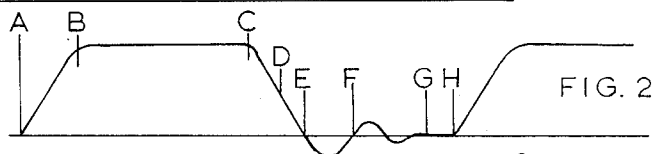


FIG. 2.

INVENTOR
Reginald Joseph Lloyd
By *Stanley H. Hall*
attorneys

1

3,124,290

MACHINES FOR AUTOMATICALLY FEEDING STRIP MATERIAL

Reginald J. Lloyd, Poole, England, assignor to Humphris & Sons Limited, Poole, Dorset, England, a British company

Filed Oct. 13, 1961, Ser. No. 145,940

Claims priority, application Great Britain Oct. 27, 1960
7 Claims. (Cl. 226—143)

It is common practice when manufacturing articles from strip metal, or other suitable strip materials, to feed the strip automatically into the tools working the strip. The tools may be power operated by various types of presses, shears or other fabricating machines. Also, various types of mechanisms driven by the fabricating machine, or independently driven machines, are employed for feeding the strip. Although some machines are arranged to work the strip whilst the strip is being continuously fed through, e.g. flying shears or presses, the main purpose of this invention is to improve those machines into which the strip is fed intermittently. With the latter type of machines the required amount of strip is fed into the tools, the strip is then held stationary whilst the tools work the strip and as soon as the tools are clear of the strip the next automatic feed takes place. This sequence follows on progressively and automatically in order to obtain high production of articles from the strip.

Of the various types of feed mechanisms, or machines, those employing rollers have certain limitations regarding accuracy with respect to strip velocity. Particularly above certain speeds of operation, rollers feeding the strip are subject to slip relative to the material. Also inaccuracy can result from the effect of inertia of the rollers and strip at the commencement and end of the feed cycle. Slip tends to produce undersize feed length and the effect of inertia tends to produce over the required feed length. Adjustments are usually incorporated in the machines to vary the pressure between the rollers and the strip, and also to brakes or other arrangements which govern the stopping of the rollers at the end of the feed cycle. Within certain speed limitations these adjustments can produce consistency of feed length, but require a certain amount of trial and error adjustment to obtain this. For feed rates and strip velocities beyond the reasonable level for such mechanisms, further precautions need to be taken which are, in any case, an improvement even for lower speeds.

An object of this invention is to improve the accuracy of intermittent feeding of strip to required length without being dependent on speed limitations. A further object of the invention is to provide quick selection of the feed length required in order to avoid wasteful setting time due to trial and error adjustments. By improvement in feed length accuracy, material economy may be obtained by reducing the amount of wastage between successive blanks or operations on the strip, e.g. with respect to press tools.

Although improvements can be to advantage when manufacturing articles from random lengths of strip material, particular advantage can be obtained when manufacturing articles continuously from a reel or coil of strip.

According to the invention there is provided an apparatus for feeding strip material to a fabricating machine, comprising means for measuring the length of the material fed to the machine by feed means, said measuring means influencing servo control means which in turn control said feed means to feed to the machine an exact, predetermined length of strip material.

The features of the present invention will be apparent from the following description given by way of example,

2

with reference to the accompanying diagrammatic drawings in which:

FIGURES 1A and 1B together constitute a diagram showing an apparatus made in accordance with the invention; and

FIGURE 2 shows a speed-time diagram of strip movement.

Although position servo control can be used in any feed mechanism, or machine for strip material, the examples given during the following explanation are relative to a feeding machine used in a cut-to-length line for strip metal.

A typical cut-to-length line may consist of an uncoiling machine, or machines, which pay off the strip from a reel, or coil, into a reserve loop of strip between the reel and the feeding machine or into a back loop on the side of the reel remote from the feeding machine. The feeding machine draws strip from the reserve loop and feeds a measured amount through a guillotine shear. The shear is provided for cutting the strip to length after the measured amount has been fed through it. Beyond the shear is provided means of conveying and/or stacking the cut strip. Such an apparatus is shown in FIGURE 1.

The Feed Machine

This consists essentially of three pairs of rollers 10, 11 and 12, the bights of which are in a common horizontal plane. The middle pair of rollers 11 are known as the measuring rollers. The other two pairs of rollers 10 and 12 are known as the ingoing and outgoing feed rollers respectively. The strip 13 is fed through the measuring rollers 11, by the ingoing and outgoing feed rollers 10 and 12. The measuring rollers 11 are rotated by the strip 13 only. Thus, the number of revolutions of the measuring rollers 11 is directly proportional to the length of strip 13 which has passed between these rollers.

The two pairs of feed rollers 10 and 12 are driven by a D.C. motor 14 via a gearbox 75. The field winding 15 of the D.C. motor 14 is supplied from a fixed D.C. source 16, e.g. provided from A.C. supply by transformer and rectifier, and the armature 17 is fed from a D.C. generator 18. The generator 18 is rotated by a three phase induction motor 19 fed from a three phase supply 20 and the generator fields 21 and 22 are fed from an electronic amplifier 23. The generator 18 is of the split field variety so that when equal currents flow in the two fields 21 and 22 the generator 18 gives zero output. The amplifier 23 is designed to give equal currents in the two fields 21 and 22 when it receives zero D.C. input.

Therefore, if there is no input to the amplifier 23 the generator 18 will not give any output and the motor 14 will not drive the feed rollers 10 and 12.

An input of about 0.1 volt is sufficient to enable the generator 18 to give full output so it can be seen that by applying a small input to the amplifier 23, the D.C. motor 14 can be made to rotate the feed rollers 10 and 12 and draw the strip 13 from the loop (not shown). The input to the amplifier 23 is reduced to zero when the predetermined required length of the strip 13 has been fed as will be described hereinafter and the motor 14 will stop rotating the feed rollers 10 and 12 and the strip 13 will stop.

A shear shown generally at 24 and to be described in more detail later, can now be operated, and a signal can then be applied to the amplifier 23 to cause the feed motor 14 to start up again and pass the next length of the strip 13 under the shear 24. The signal to the amplifier 23 is initiated by the operation of the shear 24 by a rotary switch 25 which closes to energise relays in a start unit 26 connected to the amplifier 23.

The Measuring Unit

As the strip 13 passes between the pair of measuring

rollers 11, these rotate and drive a measuring unit shown generally at 27 which is coupled to them. The input shaft 28 of the measuring unit 27 is connected to a large disc 29 by a reduction gear 30, which in this example is 15/1. The disc 29 has two cams 31 and 32 mounted on it, of which the cam 31 is fixed and the cam 32 is adjustable. Mounted near the disc 29 is a Magslip receiver 33, which is fed from a reference voltage single-phase transformer 34, the Magslip receiver 33 having an arm 74 and a roller 35 attached to its rotor. The devices termed "Magslip" herein are also known as synchros and for example are described in publication E.1000 of Muirhead & Co., Limited of Beckenham, Kent, England and in Institution of Electrical Engineers Journal, 1947, 94, part 11A at page 227 et seq. The arm 74 and roller 35 serve as a cam follower. The roller 35 runs along the two cams 31 and 32 so that due to the shape of these cams, rotation of the rotor of the Magslip receiver 33 is obtained when the disc 29 rotates. Thus when the strip 13 moves forward to pass under the shear 24, the rotor of the Magslip receiver 33 (which we will call the cam operated Magslip receiver) rotates.

The output from the cam operated Magslip receiver 33 is fed into a phase sensitive rectifier 36. This compares the A.C. output from the Magslip receiver 33 with the A.C. reference voltage from transformer 34 and converts the phase difference into a D.C. signal suitable for feeding into the D.C. amplifier 23 through a resistive summing network 37. The D.C. signal to the amplifier 23 is positive or negative according to whether the A.C. output from the receiver 33 has a phase lead or lag with respect to the A.C. reference voltage.

The summing network 37 is a network of resistors into which several inputs are fed. The common point of the network 37 feeds directly into the amplifier 23 and there is always an input into the amplifier 23 unless the various outputs into the summing network 37 are balanced. The speed of motor 14 is controlled by the output from the cam operated Magslip receiver 33 which is in itself controlled by the position of the disc 29. Whenever there is an output from the cam operated Magslip receiver 33 (that is whenever the arm 74 is displaced from a zero position) this output will cause the motor 14 to run and turn the disc 29 via the strip 13 and the measuring rollers 11. The disc 29 is arranged to turn in such a direction that the output from the cam operated Magslip receiver 33 is reduced. This arrangement forms a position servo control system.

The D.C. Tacho-Generator

The D.C. feed motor 14 has a tacho-generator 38 coupled to its rotor. A D.C. voltage is obtained from the tacho-generator 38 when the motor 14 is rotating. This forms a source of negative velocity feedback voltage for stabilising the servo system. When the motor 14 is running the tacho-generator 38 provides a signal in opposition to that from the cam operated Magslip receiver 33 to enable the motor speed to be controlled. This is achieved by balancing at the summing point 37 the Magslip receiver output against the tacho-generator output (which is proportional to speed). Any difference between these two quantities will result in an input to the amplifier 23 which in turn will cause an output from the generator 18. Any difference in the speed of the motor 14 from the value determined by the input to the amplifier 23 from the summing point 37 will result in a corresponding difference in the negative feedback voltage developed by the tacho-generator 38, hence varying the input to the amplifier 23 in such a manner as to speed up or slow down the motor 14, as necessary, to the correct speed.

The speed of the motor 14 will, therefore, always tend to be exactly proportional to the output of the cam operated Magslip receiver 33. This in turn is almost exactly proportional to the angular displacement of the follower arm 74 from its zero position. The speed of the motor

14 can, therefore, be controlled by the shape of the cams 31 and 32. These cams are so shaped that the acceleration up to and deceleration from a predetermined maximum speed of the motor 14 are constant, and have the same value. In this example the said predetermined maximum speed reached by the strip 13 is 400 ft. per minute.

The adjustable cam 32 can be moved with respect to the fixed cam 31 so that the distance between the points on the cams that give zero output from the cam operated Magslip receiver 33 can be varied. This distance is proportional to the length of strip 13 being measured and the disc 29 upon which the cams 31 and 32 are mounted has coarse length calibrations. In this example the calibrations are in feet and inches. The adjustable cam 32 has a pointer 39 attached to it to enable the length of the strip 13 that is to be measured to be predetermined.

When the feed rollers 10 and 12 start rotating and the first length of the strip 13 starts being measured, the cam follower arrangement 74, 35 which is at the zero position on the fixed cam 31, runs down this cam and then runs up the adjustable cam 32 until it reaches the zero position on this cam. Electro-magnetic clutches 40 and 41, as a result of the cam follower arrangement 74, 35 reaching the zero position, are then changed over by means not shown to reverse the drive to the disc 29 so that on the second length of the strip 13 the roller 35 runs down the adjustable cam 32 and runs up the fixed cam 31, and so on. The feed rollers 10 and 12 will stop when the output from the cam operated Magslip receiver 33 is zero so lengths of the strip 13 will be measured that are equal to the lengths set up on the disc 29.

In this example, the measuring rollers 11 are one foot in circumference and the gear ratio of the measuring unit reduction gear 30 is 15 to 1, so the disc 29 actually covers 15 feet of measured length over 360°. It is only calibrated over 12 feet, that is for 288°. Obviously, the measuring rollers 11 will rotate one revolution for every foot of strip 13 that passes through them and the disc 29 will rotate through an angle of 24°.

The measuring system explained so far may be sufficiently accurate for some applications. However, to obtain precise measurement an additional fine measuring system is added.

As the accuracy obtainable with the Magslip and cam system alone is not very high, a fine Magslip system is used as well. A fine Magslip receiver 42 is mounted in the measuring unit and it is also rotated by the measuring rollers 11 through a gear 43 of suitable ratio. In this example, the ratio is 1/1 and the Magslip 42, therefore, does one complete revolution for every foot of the strip 13 that passes between the measuring rollers 11. The Magslip 42 can, therefore, be used to measure over a length of one foot.

A micro-switch 44 is so positioned that it will be closed by the cam follower arm 74 when the strip 13 has been fed within a short distance, e.g. 3 inches of the length required, i.e. within the fine Magslip scope of measurement. A change-over unit 45, consisting of relays, then operates to cut out the cam operated Magslip receiver 33 and the fine Magslip 42 is then used for finally positioning the strip 13.

The fine Magslip receiver 42 is fed from a fine length setting Magslip transmitter 46. In this example, the rotor at the fine setting Magslip 46 is connected to a setting disc 47 with calibrations in inches up to one foot, i.e. one revolution of the disc 47 equals one foot. Also, the disc 47 is connected through a step-up gear 48 to a further disc 49 calibrated in .010" increments up to 2", i.e. one revolution equals 2". Therefore, the disc 47 is set to the nearest inch measurement required and the disc 49 to the nearest .010", or portion of .010". The cam operated Magslip 33 is set as accurately as possible to the nearest fraction of 1". Also, the fine Magslip 46 is set as accurately as possible. The first setting disc 47 is set

to the nearest fraction of 1", and the second disc 49 to the nearest fraction of .010". For example, if 4'6½" is to be measured the coarse cam operated Magslip 33 is set to 4'6½", the first disc 47 on the fine Magslip 46 is set to 6½" and the second disc 49 to .500". Alternatively, if 4 ft. is required the three settings are 4 ft., 12", .000" respectively. In this example, the measuring unit is situated at the feeding machine, and the remainder of the control gear and fine setting discs are incorporated in a separate control desk. Therefore, the Magslips are set up to the length required before the feed machine is started.

It will be realised that if one fine Magslip receiver is used to finally position the first strip then this Magslip must be re-set to a datum in some manner before the next strip starts to be measured so that it can be used for finally positioning the strip. Time would be wasted if this was re-set after reaching the end of the first strip, so two fine Magslip receivers 42 and 50 are used and while the Magslip 42 is being used to position the strip 13, the Magslip 50 is being re-set to a datum. The Magslip 50 can then be used for measuring the next strip while the Magslip 42 is being re-set to the datum.

Obviously, the electrical inputs and outputs of the Magslips 42 and 50 will have to be changed over and this is done by relay units 51 and 65.

The re-setting is achieved by the use of a D.C. amplifier 52 and a re-set servo gearbox 53. The output from the fine Magslip receiver 42 or 50 that is to be re-set is converted into a D.C. voltage by a phase sensitive rectifier 54 and is then fed into the amplifier 52 from a summing network 55. The amplifier 52 feeds into a split field servo motor 56 whose armature is supplied from a fixed D.C. source 57, e.g. transformer and rectifier. The amplifier 52 is designed to give equal currents in each half of the split field of the servo motor 56 when there is zero input. Any input to the amplifier 52 will cause an out-of-balance to occur in the fields and the servo motor 56 will rotate one way or the other depending on the polarity of the signal at the amplifier input to drive the fine Magslip back to its datum position.

A. D.C. tachogenerator 58 is coupled to the servo motor 56 to provide a source of velocity feedback voltage at the summing network 55 for stabilising purposes.

The servo motor 56 drives one or the other of two follow-through Magslip transmitters 59 or 60. The drive can be applied to one or the other of these two transmitters 59 and 60 by means of two electro-magnetic clutches 61 and 62 and two electro-magnetic brakes 63 and 64. The clutches and brakes are operated from a D.C. source (not shown), e.g. transformer and rectifier, via changeover relays (not shown), operable by relay unit 65. The clutches and brakes are so connected that the follow-through Magslip 59 or 60 that is not being driven is held stationary by its respective brake.

When re-setting, the follow-through Magslip 59 or 60 that is being driven by the servo motor 56 is fed with a reference voltage from a reference transformer (not shown) and it is rotated so that when the strip 13 stops the fine Magslip receiver 42 or 50 being fed from the reference voltage via this follow-through transmitter 59 or 60 gives zero output.

The fine length setting Magslip 46 is set up initially so that when the length set is zero, the output is identical to the reference voltage. If a length is then set up on the fine length setting Magslip 46, this Magslip will be using the reference voltage as a datum.

After the strip 13 has stopped, relay unit 65 changes over the reference voltage and the fine length setting Magslip output, so that the Magslip chain that has been re-set to the reference voltage is now fed from the fine length setting Magslip 46 and the Magslip chain that was used for positioning the last strip is now fed from the reference voltage. This Magslip chain can then be re-set

to the datum, while the other chain is being used to measure the next length of strip 13.

The shear 24 comprises a fixed shear blade 66 and a movable shear blade 67, the latter being operated by a driven crank and flywheel arrangement 68. The cut lengths of strip material pass from the shear 24 to a conveyor 69 and then to a stacker 70.

The operation of the apparatus is best described with reference to the example given earlier of the measurement of a strip 4'6½" long. As was stated earlier, the cam operated Magslip is set as accurately as possible to 4'6½", the first disc 47 on the fine Magslip 46 is set to 6½" and the second disc 49 to .500".

The Magslip 33 and whichever of the Magslips 42 and 50 is in use are each driven by the measuring rollers 11 during the whole time that a single strip is being measured. Therefore, when the start unit 26 starts the motor 14, the Magslip 42 or 50 will rotate more than four complete revolutions. The Magslip 42 or 50 is prevented during the initial part of this time from affecting the motor 14 by the changeover unit 45, which only switches over, under control of the micro-switch 44 and hence of the Magslip 33, to permit the Magslip 42 or 50 to control the motor 14 when the strip measured by the measuring rollers 11 is within a fraction (in this example 3") of the measuring range 1' of the Magslip 42 or 50 of its desired length. As the strip 13 is fed by rollers 10, 12 the strip drives the measuring rollers 11 and the latter drive the Magslip 33, 42, 50, and the disc 29. The cam 31 moves 35, 74 to control the output from Magslip 33 which is applied via 45, 36, 37, 23 to the split field windings 21, 22 of the generator 18 whereby the speed of the motor 14 is controlled according to the shape of the cams 31, 32 and its direction forwards or backwards depends on whether the D.C. signal from the rectifier 36 or 54 is positive or negative when the length of strip reaches within three inches of the required length, the micro-switch 44 operates changeover unit 45 to switch off the Magslip 33 to the generator and to connect the fine Magslip 42 (or 50) (via 51, 45, 36, 37, 23) to the generator windings 21, 22. When the required length has been fed according to the setting on discs 47, 49 no current will be fed to the generator windings 21, 22 and the feed rollers 10, 12 will stop and the cutter 66 will be actuated. However, if the strip overshoots the desired feed length the motor 14 will be reversed. So long as the length fed is less than or greater than the required length set on 47, 49 current will be fed to the generator windings 21, 22 to cause the motor 14 to drive the feed rolls forwards or backwards until the exact required length is achieved.

Referring now to FIGURE 2 a speed-time diagram is shown in which the speed of the strip material during one cycle of operations of the apparatus shown in FIGURE 1 has been plotted against time. One complete cycle of operations covers, for example, just over two seconds.

The cycle of operations is:

A—B, constant acceleration of the strip material up to a maximum speed.

B—C, feed at maximum speed (constant).

C—D, constant deceleration, change to fine Magslip servo system at point D.

D—E, further constant deceleration up to standstill when a length in excess of the required length has been fed.

E—F, reversal of drive direction, strip material fed back to a length shorter than the required length.

F—G, further reversals of drive to achieve exact required length, shear initiated at point G.

G—H, material severed by shear, shear blade withdrawn and cycle restarted.

It will be clear that the above described apparatus permits measurement of strips of material to within the accuracy of the fine measurement Magslip 42 or 50 in cases where the desired length of strip is many times the maxi-

num measuring range of the Magslip 42 or 50. As clearly shown in FIGURE 2, the Magslip 33 controls the motor 14 only in the forward direction, while the Magslip 42 or 50 can control the motor 14 in either direction.

The invention counteracts the effect of slip and inertia which cause under or over-feed. The servo control system can be provided with sufficient damping to prevent the overshooting shown in FIGURE 2 but it has been found that this increases the time required to feed the exact predetermined length and this in turn reduces the output of the arrangement. The speed-time diagram shown in FIGURE 2 illustrates the best result obtained with the invention.

I claim:

1. In or for an apparatus for feeding strip material to a fabricating machine, said apparatus comprising reversible feed means for feeding the material, and measuring means for measuring the material fed by the feed means, the provision of length setting means driven by the measuring means and settable by the operator to a selected value, the length setting means including a fine length setting means having a predetermined measuring range and a coarse length setting means having a measuring range greater than that of the fine length setting means, control means for controlling the starting, stopping and reversing of said feed means, connecting means for operatively alternately connecting the coarse length setting means and the fine length setting means to the control means, said connecting means including switch means operable by the coarse length setting means to disconnect the said coarse length setting means from the control means and to connect the fine length setting means to the control means when said feed means has fed the strip material to within a predetermined distance from the end of the value preset on the length setting means, said distance being a fraction of the fine length setting means measuring range, and means whereby the fine length setting means operates the control means to cause the feed means to feed the strip material in a selected one of the forward and reverse directions to the selected value preset on the length setting means and cause the feed means to stop at the said value.

2. In or for an apparatus for feeding strip material to a fabricating machine, said apparatus having feed means for feeding said material to the fabricating machine, and movable means moving in accordance with the movements of the material fed by the feed means, the provision of a control apparatus comprising a synchro connected to a reference voltage and having an electrical output and a mechanical input member, movement of said input member varying the current in said output, length measuring means being driven by the said movable means and actuating said input member for reducing the current towards the end of the required length of feed of the material, a reversible electric motor for driving the feed means, a generator supplying electric current to the motor, said generator having a split field input, an amplifier supplying said split-field input, a tachogenerator driven by said motor, a phase sensitive rectifier connected with the synchro output and with a A.C. reference voltage and having a D.C. output a summing network fed with electric current from the rectifier output and from the tachogenerator and supplying D.C. current to said amplifier when the currents from the synchro and rectifier are unbalanced, said D.C. current being positive or negative according to whether the output from the synchro has a phase lead or lag with respect to the A.C. reference voltage the amplifier thereby feeding current to the split-field of such polarity as to effect forward or reverse drive of the motor according to whether the length of strip fed is too little or too much.

3. In or for an apparatus for feeding strip material to a fabricating machine, said apparatus having feed means for feeding said material to the fabricating machine and measuring means for measuring the mate-

rial fed by the feed means, the provision of a control apparatus comprising a synchro receiver connected to a reference voltage and having an electrical output and a mechanical input member, movement of said input member varying the current in said output, length setting means driven by the measuring means and actuating said input member, a reversible electric motor for driving the feed means, means for operating said motor according to the current in said synchro output, said length setting means when driven causing reduction in the speed of said motor towards the end of the feed of the required length of material.

4. In or for an apparatus for feeding strip material to a fabricating machine, said apparatus having feed means for feeding said material to the fabricating machine and measuring means for measuring the material fed by the feed means, the provision of a control apparatus comprising a reversible motor for driving the feed means, a coarse length setting means, a fine length setting means, motor control means controlling the motor so that the latter operates for forward and reverse driving and stopping, first actuating means controlled by the coarse length setting means and in turn actuating the motor control means, second actuating means controlled by the fine length setting means and in turn actuating the motor control means, and means (44, 45) controlled by the coarse length setting means for bringing the first actuating means and second actuating means alternately into operation whereby the first actuating means is in operation during the first part of the feed of the required set length and the second actuating means is in operation during the latter part of the feed of the required set length.

5. In or for an apparatus for feeding strip material to a fabricating machine, said apparatus having feed means for feeding said material to the fabricating machine and measuring means for measuring the material fed by the feed means, the provision of a control apparatus comprising a coarse setting synchro device, a fine setting synchro device, length measuring means measuring the length of strip fed, said coarse setting synchro being connected to a reference voltage and having an electrical output and a mechanical input member and a mechanical output member, movement of said input member varying the current in said output, control device driven by the length measuring means, and actuating said input member, said length measuring means also actuating said fine setting synchro device, length setting means, means whereby the length setting means controls the output current from the fine synchro device, a reversible electric motor actuating said feed means, motor control means for controlling forward reverse and stopping of the motor according to current output from the synchro devices, and switch means for connecting the coarse synchro device output to said motor control means during an initial portion of the required feed and disconnecting the coarse setting synchro device and connecting the fine setting synchro device to said motor control means during the latter portion of the required feed.

6. An apparatus as claimed in claim 3 wherein the motor control means includes a generator supplying current to the motor, said generator having split field windings, an amplifier supplying electric signals to the split-field windings, a summing network, a tachometer driven by the motor and supplying current to the network, and means connecting the network to the switch means, whereby the summing network supplies a signal to the amplifier when the tachometer current is out of balance with the current from the synchro devices.

7. In or for an apparatus for feeding strip material to a fabricating machine, said apparatus having feed means for feeding said material to the fabricating machine and measuring means for measuring the material fed by the feed means, the provision of a control apparatus comprising a first reversible motor driving the feed means, a generator coupled to the motor, said gen-

erator having split field windings, (21, 22) a length measuring means (11) driven by the strip material, a coarse length setting means (29) operated by the length measuring means, a first synchro device (33) having a mechanical input (74) controlled by the coarse length setting means and having an electrical reference voltage input (34) and an electrical output, a switch (44) controlled by said mechanical coarse length setting means (29), a changeover switch means (45) connected with said synchro output and with said switch (44), a phase sensitive rectifier (36) connected with said changeover switch means (45) and providing a D.C. current output, a first summing network (37) receiving said D.C. current output, a tachometer (38) driven by said motor and providing a D.C. current to said summing network (37), an amplifier (23) receiving signals from said summing network (37) and connected to said split field windings (21, 22) second and third synchros (42, 50) having mechanical inputs connected with said length measuring means (11) and each having a first electrical output and a second electrical output, the said first electrical outputs being connected to a first relay unit (51) which is connected to said changeover switch means (45) fourth and

fifth synchro devices (59, 60) having electrical inputs connected with said second electrical outputs, fine length setting means (47, 49), a sixth synchro device having a mechanical input connected with a said fine length setting means (47, 49) and having an electrical output, a second relay unit (65) connected to said last mentioned electrical output and connected electrically to said fourth and fifth synchro devices, a second phase sensitive rectifier (54) connected to said first relay unit, a second summing network (55), a second reversible electric motor (56), said second motor having split field windings connected to said second summing network, clutch means connecting said second motor alternately to said fourth and fifth synchro devices for restoring the second synchro device to a datum while the third is operative to control the first motor and vice versa.

References Cited in the file of this patent

UNITED STATES PATENTS

2,847,763 Thomas ----- Aug. 19, 1958

FOREIGN PATENTS

488,854 Canada ----- Dec. 16, 1952