

Oct. 21, 1941.

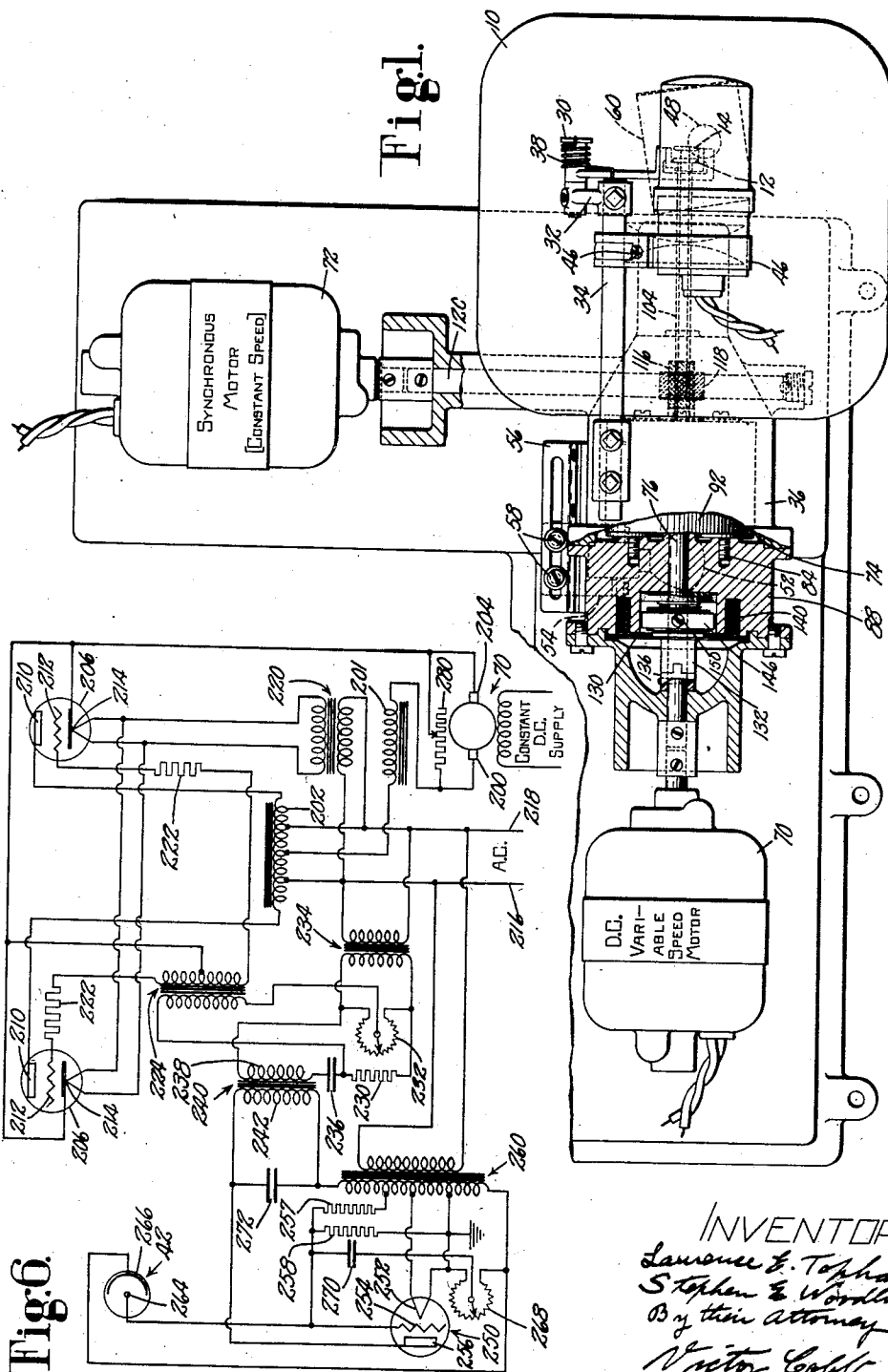
L. E. TOPHAM ET AL

2,259,502

MATERIAL HANDLING MECHANISM

Filed Dec. 22, 1939

3 Sheets-Sheet 1



INVENTORS
 Lawrence E. Topham
 Stephen E. Woodbury
 By their Attorney
 Victor Cobb.

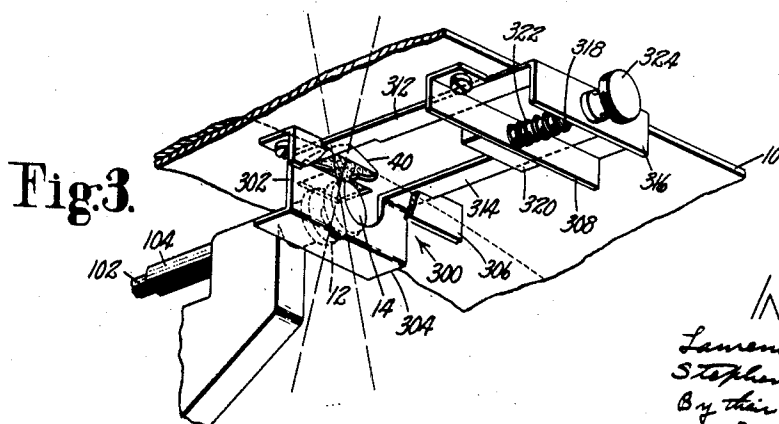
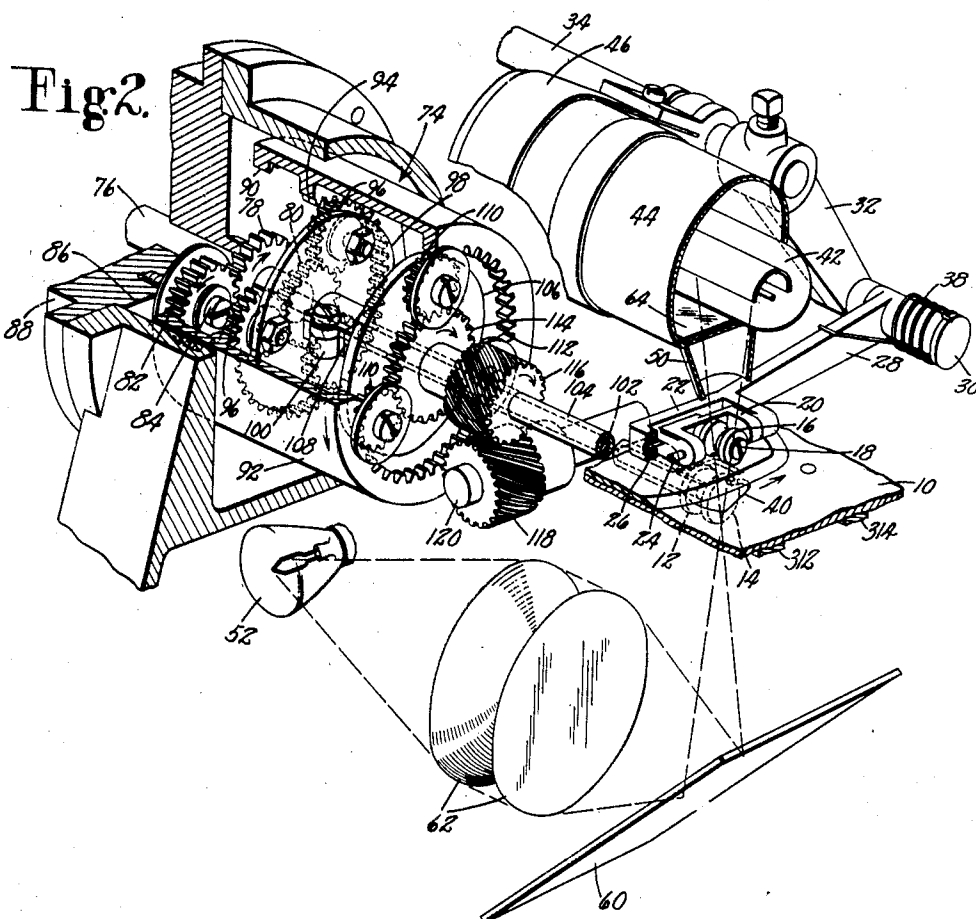
Oct. 21, 1941.

L. E. TOPHAM ET AL
MATERIAL HANDLING MECHANISM

2,259,502

Filed Dec. 22, 1939

3 Sheets-Sheet 2



INVENTORS
Lawrence E. Topham
Stephen E. Woodbury
By their Attorney
Victor Gold

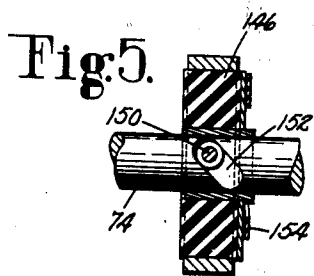
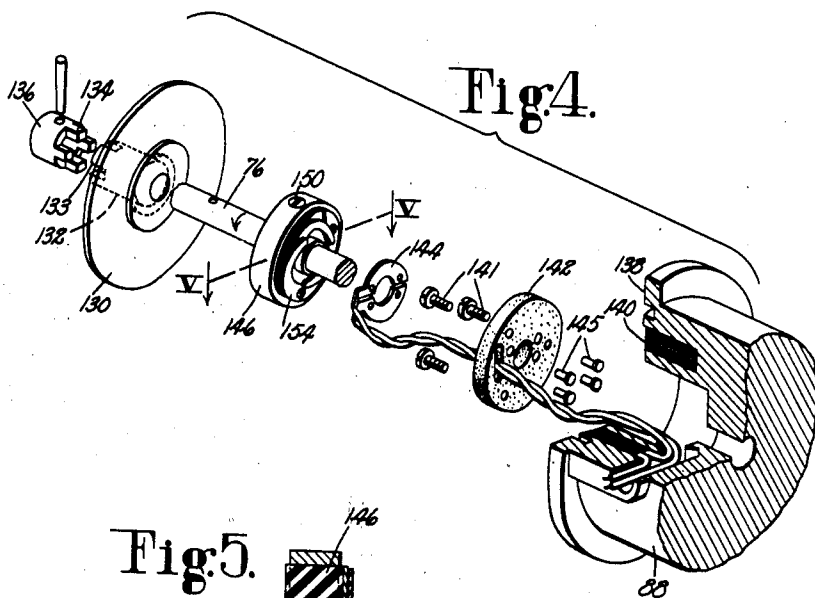
Oct. 21, 1941.

L. E. TOPHAM ET AL
MATERIAL HANDLING MECHANISM

2,259,502

Filed Dec. 22, 1939

3 Sheets-Sheet 3



INVENTORS
 Lawrence E. Tophan
 Stephen E. Woodbury
 By their Attorney
 Victor Cobb

UNITED STATES PATENT OFFICE

2,259,502

MATERIAL HANDLING MECHANISM

Laurence E. Topham, Wenham, and Stephen E. Woodbury, Beverly, Mass., assignors to United Shoe Machinery Corporation, Borough of Flemington, N. J., a corporation of New Jersey

Application December 22, 1939, Serial No. 310,586

29 Claims. (Cl. 271—52)

This invention relates to mechanisms for handling sheet material and is illustrated as embodied in a machine for feeding and guiding the edge of flexible sheet material having an irregular shape. Such a mechanism may be used for handling parts of shoe uppers wherein the margin of such parts is to have some operation such as edging, perforating, skiving, or cutting performed thereon.

One of the objects of the present invention is the provision of a photo-electrically controlled mechanism for feeding irregularly shaped sheet material in such a manner that the edge of the material is guided past a control point or station at which any desired operation may be performed thereon. The illustrated mechanism provides a pair of feed rolls arranged to engage the material adjacent to the margin thereof, the feed rolls being spaced from one another transverse to the normal direction of movement. The material passes over a support having an opening or window on one side of which is mounted a photo-electric cell receiving light through the window from a light source of constant intensity. The photo-electric cell controls the relative speeds of the feed rolls in accordance with the amount of light passing through the window in such a manner that the edge of the material is guided with respect thereto so that a desired operation may be performed on the margin of the material.

In order accurately to guide the edge of the material, the photo-electric cell must respond to minute variations in the intensity in the light passing through the window and the photo-electric cell therefore must be rendered insensitive to either direct or reflected light from other light sources. It is common practice to place a shield around the window of a photo-electric cell to prevent admission of direct rays of light from sources other than that which is intended to control the operation thereof. Such a shield, however, may be ineffective to prevent admission of reflected light to the window of the photo-electric cell. A further feature of the present invention, therefore, consists in providing a filter which permits passage only of infra-red rays to the photo-electric cell with the result that reflected light which might otherwise affect the photo-electric cell will be filtered out.

Another object of the present invention is the provision of means for causing the material being fed to leave the feeding means, if desired, after one edge of the material has passed over the window, or for causing turning of the material after a corner has reached the feeding means, to

permit two or more edges thereof to be fed thereby. To this end a shutter movable by the operator is arranged to cut off a portion of the light passing through the window in the support when the amount of control by the photo-electric cell over the feeding means is to be restricted to cause the work to run off the feeding means. When the shutter is moved to permit passage of light through the entire window, the photo-electric cell exerts maximum control over the feeding means so that the work will be turned around a sharp corner and two or more edges of the material, as desired, may be guided past the window.

The feed rolls are connected through differential gearing to a constant speed motor and to a variable speed motor, the speed of this latter motor being controlled by the photo-electric cell and controlling the difference in speeds between the rolls. In order that the variable speed motor may respond instantly to the control exerted by the photo-electric cell, means are provided for overcoming the inertia of the motor to cause rapid deceleration thereof when the photo-electric cell calls for a slowing down of this motor. To this end, and as a further feature of the invention, an electrically energized braking mechanism is provided for increasing the rate of deceleration of the driving means in response to an initial deceleration thereof.

The present invention also contemplates the provision of a photo-electrically controlled circuit including suitable amplifier and rectifier tubes for controlling the speed of a motor in response to minute variations in the intensity of light reaching the photo-electric cell, wherein the circuit controlled thereby is rendered insensitive to body capacity so that the presence of an operator will have substantially no effect thereon.

These and other important features of the invention will now be described in detail in the specification and pointed out more particularly in the appended claims.

In the drawings,

Fig. 1 is a plan view, partly in section, of one form of mechanism embodying the principles of the present invention,

Fig. 2 is an enlarged view partly in section of a portion of the mechanism illustrated in Fig. 1, illustrating the gearing from which the feed rolls are driven;

Fig. 3 is a bottom view of the work support illustrating the shutter by which the effective size of the window therein may be varied;

Fig. 4 is an exploded view of the brake mechanism by means of which rapid deceleration of the variable speed motor is accomplished;

Figure 5 is a sectional view taken on the line V—V of Fig. 4; and

Fig. 6 is a wiring diagram of the electrical apparatus employed for controlling the operation of the mechanism.

A work support, 10 is provided over which the material is fed and with which may be associated any suitable mechanism for operating upon the margin of the work. A pair of feed rolls 12 and 14 are mounted below the work support and extend through the surface thereof to engage the under side of a work piece to impart a feeding movement thereto. The feed rolls 12 and 14 are arranged to be operated at relatively varying speeds by mechanism to be hereinafter described so as to feed the work in the desired direction. A roll 16 (Fig. 2) having spaced work engaging surfaces located opposite to the rolls 12 and 14 is arranged to maintain the work in engagement with the feed rolls. The roll 16 is mounted for free rotation by means of a screw 18 threaded into a U-shaped rockably mounted support 20. The support 20 is pivotally mounted in a yoke 22 by means of aligned pivots extending at right angles to the axis of rotation of the roll 16, one of these pivots being indicated by the reference character 24. A pin 26 carried by the support 20 extends into an enlarged hole in the outer arm of the yoke 22 and limits the rocking movement of the roll support 20. By reason of this rockable support for the roll 16, it is self-adjustable to compensate for variations in thickness of the work passing between this roll and the feed rolls.

The yoke 22 is formed at the end of an arm 28 fulcrumed on a pin 30 carried by the lower end of a bracket arm 32. The upper end of this bracket arm is fixed to a supporting rod 34, the other end of which is supported on the upper end of a gear casing 36 (Fig. 1). A coil spring 38 is secured at one end to the head of the pin 30 and the other end bears against the upper side of the arm 28 to urge this arm downwardly, whereby the roll 16 will be forced under spring pressure against the upper surface of the work.

An opening 40 is provided in the work support 10 and is arranged to be partially covered by the work piece. This opening forms a window by means of which light passes from a light source to a photo-electric tube 42 and serves as a central point or station with respect to which the work is guided. The tube 42 is mounted in a casing 44 secured by a strap 46 to the supporting rod 34. The housing 44 completely surrounds the photo-electric tube 42 except for an opening 48 (Fig. 1) opposite to the window 40 in the work support 10. In order to prevent direct rays of light with the exception of those from the intended light source from reaching the tube 42, the opening 48 is surrounded by a downwardly extending frusto-conical shield 50. The light source may comprise a bulb 52 located below the work support 10 and mounted in a slidable support 54 (Fig. 1). The support 54 is slidably connected to a slotted bracket 56 and may be retained in any desired position by means of screws 58. A mirror 60 reflects light from the bulb 52 upwardly through the window 40 in the work table 10 to the photo-electric tube 42. Condensing lenses 62 are located between the bulb 52 and the mirror 60 to guide the rays to the mirror from which they are reflected through the window 40 to the photo-electric tube. The focus of

the light rays is located slightly below the support 10 so that they are slightly diffused upon passing through the opening 40 to facilitate control of the amount of light to the tube 42 by means of the work piece. If desired, the light rays might be focused slightly above the support 10 and the same result would be accomplished.

While the shield 50 is effective in preventing direct rays of light except those from the bulb 52 from reaching the photo-electric tube 42, this shield does not prevent reflected light from other sources from being reflected from the support 10 to the tube 42. The photo-electric tube is arranged to control the feeding mechanism in response to small variations in the intensity of light reaching the tube and, consequently, the desired control of the work piece would not be secured if reflected light of varying intensities were permitted to reach the tube. Accordingly, a filter 64 is placed over the window 40, this filter being of such character that it permits passage of only infra-red rays. Infra-red light rays are not absorbed by the mirror 60, but surfaces such as that of the work support 10, or work pieces being fed thereover, will absorb infra-red rays. Accordingly, light rays from the bulb 52 will reach the photo-electric tube, but light reflected by the work support from an overhead light for example will not pass through the filter 64. The operation of the photo-electric tube is therefore not affected by such reflected light, and since the shield 50 prevents direct rays of outside light from reaching the photo-electric tube, it will respond accurately to the amount passing through the window 40 from the bulb 52.

The mechanism for driving the feed rolls 12 and 14 at variable speeds will now be described. These rolls are driven by a variable speed direct current motor 70, a constant speed motor 72, and a differential gear train indicated generally by the reference character 74. The variable speed motor 70 drives a shaft 76 on which the mounted spur gears 78 and 80. The gear 78 engages idler gears 82, the journals for which are formed on screws 84 threaded into a wall 86 of a housing 88. The idler gears 82 engage the teeth of a ring gear 90 carried by a rotatable housing 92. The housing 92 also carries a second ring gear 94 with which engage gears 96 carried by a disc 98 which is fixed by means of a split clamp 100 to a shaft 102 journaled in the outer end of the shaft 76. The gears 96 also engage the gear 80 carried by the shaft 76, and the relative speeds of the gear 80 and the ring gear 94 will determine the speed of rotation of the disc 98 carrying the gears 96, and accordingly the speed of rotation of the shaft 102. The outer feed roll 14 is carried by the outer end of the shaft 102 and accordingly the speed of this roll will vary in accordance with variations in the speed of the disc 98 which, in turn, varies as the speed of the motor 70 because of the differences in the ratios of the ring gears 90 and 94 and of the gears 78 and 80.

By way of example, the gear 78 may be considered as having 32 teeth, the gears 82 as having 30 teeth, and the ring gear 90 as having 92 teeth. The ring gear 94 may be considered as having 72 teeth, the gears 96 as having 24 teeth, and the gear 80 as having 24 teeth so that a different gear ratio exists between the gears 78 and 80 from that between the gears 80 and 94. With these gear ratios, if it be assumed that the shaft 76 varies in speed from approximately 1,069

R. P. M. to 1,204 R. P. M., the speed of the outer feed roll will vary from approximately 11.6 R. P. M. to 13.1 R. P. M. It will, accordingly, be seen that the speed of the outer roll varies in direct relationship with the speed of the drive shaft 76.

The inner feed roll 12 is carried by a sleeve 104 surrounding the shaft 102. A disc 106 is secured to the inner end of the sleeve 104 by means of a split clamping collar 108. Rotatably mounted on the disc 106 are gears 110 which engage a ring gear 112 carried by the rotatable housing 92. The gears 110 also engage a gear 114 rigid with a skew gear 116, these gears being rotatably supported on the sleeve 104. The gear 116 meshes with a second skew gear 118 carried by a driving shaft 120 which is driven by the constant speed motor 72.

The rate of rotation of the housing 92 varies in accordance with the variations in the speed of the driving shaft 76, whereas the rate of rotation of the gear 114 will be constant at all times during the operation of the mechanism. Since the gears 110 carried by the disc 106 engage the ring gear 112 carried by the housing 92 and also engage the constant speed gear 114, the rate of rotation of the disc 106 and consequently of the inner feed roll 12 will depend upon the difference in speeds of the ring gear 112 and the gear 114.

For purposes of illustration, the gear 114 may be assumed to have 36 teeth, gears 110 to have 18 teeth, and the ring gear 112 to have 72 teeth. The gear 114 may be assumed to be driven by the constant speed motor at 762.5 R. P. M. at all times. As the speed of the shaft 76 varies between the limits noted above, the housing 92 carrying the three ring gears will vary in speed from approximately 371.9 R. P. M. to 418.7 R. P. M. Accordingly, the disc 106 to which the feed roll 12 is connected by means of the sleeve 104 will vary in speed from approximately 6.25 R. P. M. in the direction opposite to that in which the outer roll 14 is rotating, through zero to 25 R. P. M. in the same direction as the feed roll 14. Since there is a 2:1 ratio between the gears 112 and 114, the disc 106 will be stationary when the gear 114 rotates twice as fast as the gear 112, it being understood that these gears rotate in opposite directions.

It will, accordingly, be seen that while the speed of the outer roll 14 varies directly as the speed of the variable speed motor, the speed of the inner feed roll 12 will vary at a much higher rate, and as the speed of motor 70 varies between the limits mentioned above, there will be a reversal in direction of rotation of this roll, although the motor 70 is always rotating in the same direction, the only change in the operation of the motor being in the rate of rotation thereof. It will also be noted that the percentage change in rate of rotation of the inner roll 12 is high compared to the percentage change in rate of rotation of the driving motor 70, so that the speed of this motor may be controlled within a relatively small range to obtain a high range of speed change of the feed roll 12. Accordingly, the direction of feed of the work engaged by the feed rolls may be rapidly varied without greatly varying the speed of the motor 70. The speeds and gear ratios mentioned above are not critical and may be varied as desired in accordance with any desired speed change of the inner roll for a given speed change in the variable speed motor. The ratios specified above have been found to produce very good results.

In order to insure rapid deceleration of the variable speed motor, in response to a call for a reduced speed of the inner roll 12 by the photo-electric tube 42 and the circuits controlled thereby, a brake is provided on the shaft 76. A brake member 130 is mounted on the shaft 76 for sliding movement with respect thereto but is prevented from rotating relative thereto by means of the hub 132 having projections 133 fitting between projections 134 of a collar 136 pinned to the shaft 76. The outer portion of the brake 130 is arranged to engage a surface 138 of the casing 88 when attracted by a magnet coil 140 embedded in a recess in the casing, the brake member 130 being made of magnetic material such as iron. The casing 88 is recessed at the central portion thereof and secured therein by screws 141 is a block 142 of insulating material. Switch contacts 144 are secured by rivets 145 to the block 142 and when the contacts are electrically connected, they close a circuit through the magnet coil to energize the same. A switch member 146 is slidably secured to the shaft 76 by means of a pin 150 engaging a slot 152 in the shaft (Fig. 5). The slot 152 is helically arranged in the shaft and is so arranged that when the shaft is accelerating, the switch member 146 will move away from the contact members 144 by reason of the inertia thereof and will move in the opposite direction when the shaft starts to decelerate. The switch member 146 carries three contact members 154 which complete the circuit through the fixed contact members 144 upon movement of the switch member 146 toward these contact members by reason of a slight deceleration of the shaft 76. As soon as the shaft begins to decelerate and the circuit is closed through the fixed contact members 144, the magnet coil is energized, thus attracting the brake 130 which engages the surface 138 of the casing 88. Since the brake member is fixed against rotation with respect to the shaft 76, a braking action is exerted thereon, tending to increase the rate of deceleration of the shaft 76 and, accordingly, of the motor 70. As soon as the motor 70 begins to accelerate under the control of the photo-electric tube 42, the switch member 146 will move away from the fixed contact members 144, thus interrupting the circuit through the magnet coil 140 so that the brake 130 is no longer attracted thereby, whereupon the braking effect is relieved.

The diagram of the electrical apparatus by means of which the speed of the motor 70 is varied in response to the light received by the photo-electric tube 42 is illustrated in Fig. 6. The field winding of the motor 70 is connected as indicated to a constant direct current supply. The brush 200 of the motor is connected through a reactor 201 to the center terminal of an auto-transformer 202. The other brush 204 of the motor 70 is connected to the cathodes of a pair of discharge devices 206. These devices are of the three electrode type as shown, being provided with plates or anodes 210, grids 212, and heated cathodes 214. The electric discharge devices are preferably of the type in which a small quantity of an inert gas or vapor such as mercury vapor is introduced after the air has been exhausted therefrom, the presence of the inert gas serving to permit the formation of an arc discharge so that the devices constitute grid-controlled arc rectifiers. Such devices are sold in one form under the name "Thyratron" and the devices will be so referred to hereinafter.

The plates 210 of the Thyratrons are connected to the outer terminals of the auto-transformer 202, this transformer being supplied by means of the supply lines 216 and 218 with alternating current from any suitable source. The heaters of the cathodes 214 of the Thyratrons are connected to the secondary of a filament transformer 220, the primary winding of which is connected to the supply lines 216 and 218. The grids 212 of the Thyratrons are connected respectively through protective resistances 222 to the secondary of a grid transformer 224, the center terminal of which transformer is connected to the cathodes 214 of the Thyratrons.

The primary winding of the grid transformer 224 is in a bridge circuit from an intermediate point of a potentiometer 232 to a common connection between a resistance 230 and a winding 238 of a saturable reactor 240 with its condenser 236. The potentiometer 232 is connected to the secondary of a transformer 234, the primary of which is connected to the supply lines 216 and 218. The potentiometer 232 is provided for obtaining an adjustable intermediate tap of the transformer 234, whereby the voltage applied to the grid transformer 224 may be set at the desired initial value. The variable reactance of the saturable reactor 240 determines the phase relationship between the grids and anodes of the Thyratrons, thus governing the amount of current conducted by the tubes and, accordingly, governing the current through the armature of the motor 70 which in turn controls the speed of rotation of the motor.

The circuits which have been described up to this point and their operation in controlling apparatus such as electric motors are well known and should require no further explanation.

The amount of direct current through the winding 242 of the saturable reactor 240 is controlled by the amount of light passing to the photo-electric tube 42 in a manner to be now described. The control is effected through an amplifier tube 250 which is of the three electrode type containing a filament 252, a grid 254, and a plate 256. The photoelectric tube 42 is so connected to the amplifier tube 250 that the current passing through the latter decreases in response to an increase of light received by the photo-electric tube. The amplifier tube 250 also acts as a rectifying tube. Therefore, in view of the rectifying effect of the photo-electric tube 42 and of the amplifier tube 250, the alternating currents from the secondary winding of a transformer 260, the primary winding of which is connected to the supply lines 216 and 218, are changed into pulsating direct currents in the photo-electric and amplifier tubes. The circuits to be described may therefore be considered as supplied with direct current.

The grid 254 of the amplifier tube 250 is connected through a relatively high resistance 257 to a 30 volt tap which may be considered a positive tap on the transformer 260. The filament 252 of the amplifier tube is heated from suitable taps on the secondary of the transformer 260 and one side of the filament is connected both to the grid 254 through a relatively low resistance 258 and also to ground as indicated. The anode 264 of the photo-electric tube is connected to the grid 254 of the amplifier tube and the cathode 266 of the photo-electric tube is connected to what may be considered the negative side of the secondary of the transformer 260. A potentiometer 268 is connected across

the 30 volt negative side of the transformer 260 and the arm of the potentiometer 268 is connected through a condenser 270 to the grid of the amplifier tube 250. One side of the direct current winding 242 of the saturable reactor 240 is connected to the positive high voltage terminal of the transformer 260 and the other side of this winding is connected to the plate 256 of the amplifier tube. A condenser 272 is placed across the terminals of the coil 242 of the saturable reactor.

When no light rays are received by the photo-electric tube 42, the amplifier tube 250 will conduct, because of the connection between the grid 254 through the relatively high resistance 257 to the positive side of the transformer. Upon passage of light to the photo-electric tube 42, a minute extra current flows through the resistance 257 the return being to the grounded side of the filament. This causes a drop in the positive voltage applied to the grid of the amplifier tube. This drop in voltage by itself is insufficient for control purposes but inasmuch as the cathode 266 of the photo-electric tube is connected to the negative side of the transformer at the end of the potentiometer remote from the filament 252, the potentiometer is available for control and augments the response by enabling the positive voltage applied to the grid 254 to be partly canceled by a portion of the negative voltage from the transformer 260 as determined by the position of the potentiometer arm. The grid of the amplifier tube is positive when the photo-electric tube is dark and becomes gradually negative as the illumination of the photo-electric tube is gradually increased. The response to the amplifier tube is accordingly in inverse relationship with the illumination of the photo-electric tube.

The sensitive cathode 266 of the photo-electric tube is connected to the negative side of the transformer which is very nearly the ground connection so that it is unnecessary to take any unusual precautions to render the photo-electric tube insensitive to external influence. The less sensitive anode of the photo-electric tube, which is directly connected to the grid of the amplifier tube, has the relatively low resistance 258 continuously serving as a grid leak to render both the photo-electric tube and the amplifier tube insensitive to external influence. By this arrangement, body capacity of the operator and other similar external influences will have no appreciable effect upon the operation of the apparatus and it is unnecessary to take any precautions to keep the operator away from the tubes.

A shunt load of approximately 30 ohms is provided by a variable resistance 280 for the motor 70, thus maintaining a constant load on the motor so as to impart regenerative braking thereto and assist the brake 130 in causing rapid deceleration thereof. The use of this shunt resistance 280 in imparting a constant load on the motor may impart sufficient braking action thereon so that the brake 130 may in some instances be dispensed with.

When no light is received by the photo-electric tube 42, the current flow through the amplifier tube 250 will be at a maximum so that a sufficient amount of direct current will flow through the winding 242 of the saturable reactor 240 to nearly saturate the core of this reactor so that the reactance of the winding 238 drops to a minimum value. The current flow through the thyratrons

will accordingly be at a maximum value so that a high voltage will be applied to the armature of the direct current motor 70 to drive the inner feed roll at a high speed relative to the outer feed roll. If now the photo tube begins to receive light, the current flow through the amplifier tube 250 will decrease in proportion to the increase in the intensity of light passing to the photo-electric tube, and as the current through the tube 250 decreases, the direct current through the winding 242 of the saturable reactor will likewise decrease. As the current through the winding 242 decreases, the core of the saturable reactor becomes less and less saturated so that the reactance of the winding 238 will increase to vary the phase relationship between the grids and plates of the thyatron, which will result in the passage of a smaller amount of current therethrough. The voltage applied to the armature of the motor 70 will therefore decrease, thus causing a decrease in the speed of the motor. As the speed of the motor 70 decreases, the speed of the inner feed roll 12 will decrease relative to the outer roll 14 so that the work being fed thereby will be turned in a direction to reduce the intensity of light passing through the window 40 in the work support 10.

Referring to Fig. 3, the shutter, by means of which the effective area of the light window 40 may be varied, is illustrated. The shutter 300 comprises a vertical wall 302, and a horizontal wall 304 which serves to obstruct the passage of light through a portion of the window 40 when the shutter is in the position illustrated. The shutter is slidably carried on the under side of the work support 10 by means of gibs 306 and 308 between which and the table 10 are supported the spaced extensions 312 and 314 of the shutter 300. The vertical wall 302 of the shutter is cut away so that upon movement of the shutter inwardly to permit the light from the bulb 52 to pass through the entire area of the window, the vertical wall of the shutter may move past the feed rolls.

The extensions 312 and 314 terminate in a downwardly extending portion 316 through which passes a screw 318 threaded into a block 320 connected to the gib 306. A spring 322 surrounding the screw 318 acts between the gib 308 and the portion 316 of the shutter to urge the shutter outwardly of the work support 10 to the position illustrated in Fig. 3. The screw 318 is provided with a head 324 by means of which the screw may be adjusted in the block 320 adjustably to limit movement of the shutter outwardly of the work support by the spring 322.

With the shutter in the position illustrated, the effective area of the light window 40 is reduced so that less light is permitted to reach the photo-electric tube 42 than if the shutter is moved inwardly against the force of the spring 322. Accordingly, with the shutter in its outer position, the range of control over the feed rolls by the photo-electric tube is less than when the shutter permits passage of light through all portions of the window. Accordingly, if the shutter is obstructing part of the window, the amount that the work being fed over the work support may be turned is limited to such an extent that when a sharp corner of the work reaches the feed rolls, the work will not be turned sufficiently and will be thrown out of the feed rolls. This is desirable when only one edge of a piece of work is to have an operation performed thereon. If, however, two or more edges of the work are to be

operated upon, the operator will move the shutter 304 inwardly against the force exerted by the spring 322 so that more light is permitted to reach the photo-electric tube when a corner of the work reaches the feed rolls whereby a greater turning movement is imparted to the work to maintain the work under control of the feed rolls until the operator permits the shutter to move back to the position illustrated in Fig. 3. Accordingly, the effective area of the window is always under the control of the operator so that any desired number of edges may be fed thereover.

Having thus described our invention, what we desire to secure by Letters Patent of the United States is:

1. A mechanism for handling irregularly shaped sheet material comprising a support, means for feeding irregularly shaped sheet material over the support, means for operating said feeding means to vary the direction of feed of the material, and photoelectrically controlled means responsive to the position of the edge of the material in control of said operating means to vary the direction of feed of the material in accordance with irregularities of the edge to guide the edge of the material with respect to a control point.

2. A mechanism for handling irregularly shaped sheet material comprising a work support, feeding means arranged to engage the material adjacent to the edge thereof to feed the material over the support, means for operating said feeding means to vary the direction of feed of the material, and photoelectrically controlled means responsive to the position of the edge of the material in control of said operating means to vary the direction of feed of the material in accordance with irregularities of the edge to maintain the edge of the material at a substantially uniform distance from said feeding means.

3. A mechanism for handling irregularly shaped sheet material comprising a pair of feed rolls arranged to engage the material at spaced points inwardly of the edge thereof, and photoelectrically controlled means responsive to the distance between said rolls and the edge of the material to maintain the edge of the material at a substantially uniform distance from said rolls.

4. A mechanism for handling irregularly shaped sheet material comprising a pair of feed rolls arranged to engage one side of the material adjacent to the edge thereof, and photoelectrically controlled means responsive to the position of the edge of the material in control of the relative speeds of said rolls to maintain the edge of the material at a substantially uniform distance from said rolls.

5. A mechanism for handling irregularly shaped sheet material comprising a pair of feed rolls arranged to engage one side of the material adjacent to the edge thereof, a constant speed motor, a variable speed motor, differential gearing between said motors and said feed rolls to drive said rolls at variably different relative speeds in accordance with the speed of said variable speed motor, and means controlling the operation of said variable speed motor to maintain the edge of the material at a substantially uniform distance from said rolls.

6. A mechanism for handling irregularly shaped sheet material comprising a pair of feed rolls arranged to engage one side of the material

adjacent to the edge thereof, said rolls being spaced from one another transversely with respect to the direction of feed of the material, a variable speed motor, a constant speed motor, differential gearing between said motors and rolls to drive said rolls at variably different relative speeds in accordance with the speed of said variable speed motor, and means controlling the operation of said variable speed motor to maintain the edge of the material at a substantially uniform distance from said rolls.

7. A mechanism for handling irregularly shaped sheet material comprising material feeding means, a work support for said material adjacent to said feeding means, a window in said work support over which the material is fed, a light source on one side of said window, a photo-electric cell on the other side of said window receiving light from said light source, mechanism controlled by said photo-electric cell in response to the amount of light passing through said window past the edge of the material being fed thereover for controlling said feeding means to cause a substantially uniform portion of said window to be covered by the material as the material is moved thereover by the feeding means.

8. A mechanism for handling irregularly shaped sheet material comprising material feeding means, a support for said material adjacent to said feeding means, a window in said support, a light source on one side of said window, a photo-electric cell at the other side thereof receiving light from the light source through said window, means operated by said photo-electric cell in response to the amount of light passing through said window past the edge of the material being fed thereover from said light source for controlling the feeding means to feed the edge of the material over a predetermined part of the window, and means rendering said photo-electric cell insensitive to light except from that coming from said light source.

9. A mechanism for handling irregularly shaped sheet material comprising material feeding means, a support for said material adjacent to said feeding means, a window in said support, a light source on one side of said window, a photo-electric cell at the other side thereof receiving light from the light source through said window, means operated by said photo-electric cell in response to the amount of light passing through said window from said light source past the edge of the material being fed over the window for controlling the feeding means to feed the edge of the material over a predetermined part of the window, and means rendering said photo-electric cell insensitive to light except from that coming from said light source, said means comprising a filter for filtering all the light rays except those in the infra-red range.

10. A mechanism for handling irregularly shaped sheet material comprising material feeding means, photo-electrically controlled means responsive to the position of the edge of the material in control of said feeding means to guide the edge of the material past a control point, and means selectively rendering said photo-electrically controlled means effective or ineffective to cause the material to turn sufficiently when a sharp corner is reached to remain in engagement with the feeding means.

11. Mechanism for handling irregularly shaped sheet material comprising material feeding means, a support for said material adjacent to

said feeding means, a window in said support over which the material is fed, a light source at one side of said support, a photo-electric cell at the other side of said support receiving light from said light source through said window, means operated by said photo-electric cell in response to the amount of light passing through said window to control said feeding means to cause a substantially uniform portion of said window to be covered by said feeding means, and means located below said support for obstructing a portion of said window, said means being movable away from said window whereby the amount of control over the feeding means by the photo-electric cell may be increased.

12. Mechanism for handling irregularly shaped sheet material comprising material feeding means, a support for said material adjacent to said feeding means, a window in said support over which the material is fed, a light source at one side of said support, a photo-electric cell at the other side of said support receiving light from said light source through said window, means operated by said photo-electric cell in response to the amount of light passing through said window in control of said feeding means to cause a portion of said window to be covered by said feeding means, a shutter slidably located below said window for movement between positions in which it partially obstructs the window and permits the entire window to be effective for passage of light to the photo-electric tube, and means urging said shutter to said first-named position.

13. A control mechanism comprising light-sensitive means, a light source therefor, mechanism controlled by said light-sensitive means in response to the intensity of light reaching said means from said light source, and means preventing variations in light intensity except from said light source from affecting the responsiveness of said light-sensitive means.

14. A control mechanism comprising light-sensitive means, a light source therefor, mechanism controlled by said light-sensitive means in response to the intensity of light reaching said means from said light source, means preventing variations in intensity of light except from said light source from affecting the responsiveness of said light-sensitive means, said means comprising a housing surrounding said light-sensitive means and permitting direct rays of light reaching said light-sensitive means from said light source only, and a filter in said housing through which all the light reaching said light-sensitive means must pass, said filter being constructed and arranged to permit passage of light rays in the infra-red range only.

15. In a control mechanism, a photo-electric tube, a housing surrounding said tube and having a small opening therein for passage of light rays to said tube, and a filter over said opening permitting passage of only infra-red rays thereto.

16. In a feeding mechanism, a pair of rolls of substantially equal diameter adapted to engage a work piece at spaced points adjacent to the margin thereof, and means for simultaneously rotating said rolls at different speeds.

17. A feeding mechanism comprising a pair of concentrically arranged rolls adapted to engage a work piece at spaced points adjacent to the margin thereof, means for simultaneously rotating said rolls at different speeds, and means for varying the relative speeds of said rolls.

18. A feeding mechanism comprising a pair of

feed rolls adapted to engage a work piece at spaced points adjacent to the margin thereof, and means for rotating said rolls at relatively varying speeds to vary the direction of feed of the work piece.

19. A feeding mechanism comprising a pair of rolls adapted to engage a work piece at spaced points adjacent to the periphery thereof, means for simultaneously rotating said rolls, and means for varying the relative speeds of said rolls in response to variations in the distance of the margin of the material from said rolls.

20. A mechanism for handling irregularly shaped sheet material comprising a pair of feed rolls arranged to engage the material adjacent to the edge thereof, means for driving said rolls at variably different relative speeds, said means including a variable speed motor, means controlling the operation of said variable speed motor to maintain the material being fed in a predetermined relationship with respect to said feed rolls, and means responsive to a deceleration of said variable speed motor for exerting a braking action thereon to increase the rate of deceleration of said motor.

21. A mechanism for handling irregularly shaped sheet material comprising a pair of feed rolls arranged to engage the material adjacent to the edge thereof, means for driving said rolls at variably different relative speeds, said means including a variable speed motor, means controlling the operation of said variable speed motor to maintain the material being fed in a predetermined relationship with respect to said feed rolls, a magnetically operated brake associated with said variable speed motor, and means responsive to a deceleration of said motor for energizing said magnetically operated brake to increase the rate of deceleration of said motor.

22. A feeding mechanism comprising a feed roll, a variable speed motor controlling the operation of said feed roll to feed material in a predetermined manner, means for controlling the speed of rotation of said variable speed motor, braking means associated with said motor, and means operable in response to initial deceleration of said motor for energizing said braking means.

23. A drive shaft, a disc of magnetic material rotatable therewith and mounted for limited sliding movement thereon, a braking surface cooperating with said disc when said disc is in one extreme position for imparting a braking action to said shaft, a magnet coil associated with said braking surface and adapted when energized to move said disc to said one extreme position, and means operative in response to a deceleration of said shaft for energizing said magnet coil.

24. A drive shaft, a disc of magnetic material rotatable therewith and mounted for limited sliding movement thereon, a braking surface cooperating with said disc when said disc is in one extreme position for imparting a braking action to said shaft, a magnet coil associated with said braking surface and adapted when energized to move said disc to said one extreme position, a circuit closing device on said shaft, means connecting said circuit closing device to said shaft for axial movement in one direction in response to deceleration of said shaft and for axial movement in the opposite direction in response to acceleration of said shaft, and contact members arranged to be engaged by said circuit closing device when moved in said one direction to close a circuit through said magnet coil.

25. A mechanism for handling irregularly

shaped sheet material comprising a pair of feed rolls arranged to engage the material adjacent to the edge thereof, means for driving said rolls at variably different relative speeds, said means including a variable speed motor, current amplifying means controlling the flow of current to said variable speed motor, light responsive means controlling the flow of current through said amplifying means in response to the position of the material relative to said rolls, and circuit connections between said light responsive means, said current amplifying means, and said variable speed motor for rendering said light responsive means and said current amplifying means insensitive to external conditions.

26. A mechanism for handling irregularly shaped sheet material comprising a pair of feed rolls arranged to engage the material adjacent to the edge thereof, means for driving said rolls at variably different relative speeds, said driving means including a variable speed direct current motor, current amplifying and rectifying means controlling the flow of current to said variable speed motor, light responsive means controlling the flow of current through said amplifying and rectifying means in accordance with the position of the material relative to said rolls, and circuit connections between said light responsive means, said current amplifying and rectifying means, and said variable speed motor for rendering the electrical apparatus insensitive to external influence.

27. A control system for a mechanism for feeding irregularly shaped sheet material comprising a direct current variable speed motor controlling the operation thereof, means for controlling the speed of a said motor comprising a source of alternating current and an electric discharge device provided with a control grid and an impedance phase-shifting circuit energized from said alternating current source for exciting said grid, said circuit including a photo-electric tube and an amplifier tube, and connections between said photo-electric tube, said amplifier tube and the source of alternating current for rendering said photo-electric tube and said amplifier tube insensitive to external influences.

28. A control system for a mechanism for feeding material comprising a direct current variable speed motor, means controlling the speed of said motor comprising a source of alternating current and an electric discharge device provided with a control grid and an impedance phase-shifting circuit energized from said alternating current source for exciting said grid, said circuit including a saturable reactor the alternating current side of which supplies current to said grid, a rectifying circuit for supplying direct current to said saturable reactor in varying amounts so as to control the impedance of the alternating current side thereof, a photo-electric tube and an amplifying tube controlling the flow of direct current through said saturable reactor, and circuit connections between said photo-electric tube, said amplifying tube, and the source of alternating current for rendering said photo-electric tube and said amplifying tube insensitive to external influences.

29. A light responsive control system comprising a controlled element arranged to be supplied with variable direct current, an electric discharge device provided with a control grid, said electric discharge device controlling the supply of direct current to said control device, a saturable reactor comprising a pair of windings and a sat-

urable core, one of said windings being connected to a source of alternating current and supplying voltage to said grid, a rectifier and amplifier tube connected to the other winding of said saturable reactor and arranged to supply direct current in varying amounts thereto, said tube having a grid, a plate, and a filament, and a photo-electric device having an anode and a cathode, the anode of said photo-electric device being connected to the grid of said tube and also being connected through a relatively low resistance to ground, the cathode of said photo-electric device being connected to the source of al-

ternating current and the filament of said tube, the grid of said tube and the anode of said photo-electric device being connected through a relatively high resistance to the source of alternating current, the connection between the cathode of said photo-electric device and the alternating current source being very near the ground connection whereby the photo-electric device and the tube are rendered insensitive to external influences.

LAURENCE E. TOPHAM.
STEPHEN E. WOODBURY.