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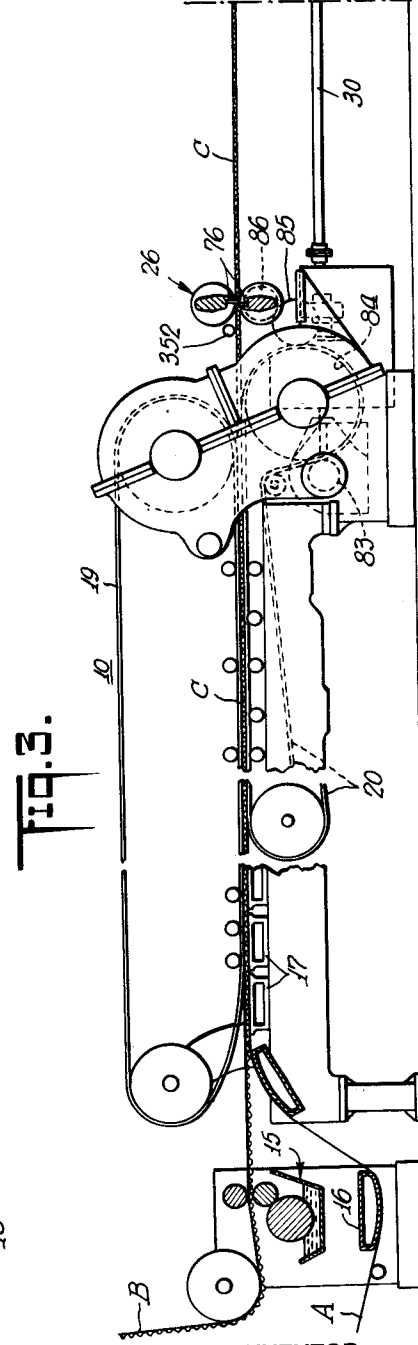
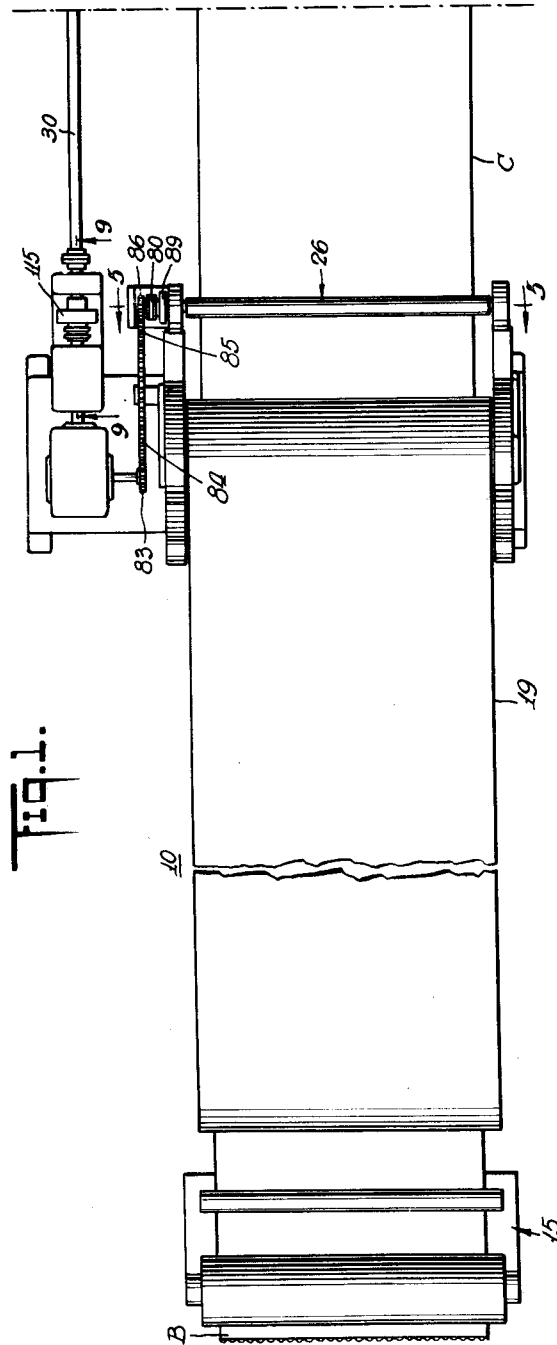
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2,309,728

PRODUCTION OF PAPER BOARD UNITS

Filed Nov. 14, 1941

8 Sheets-Sheet 1



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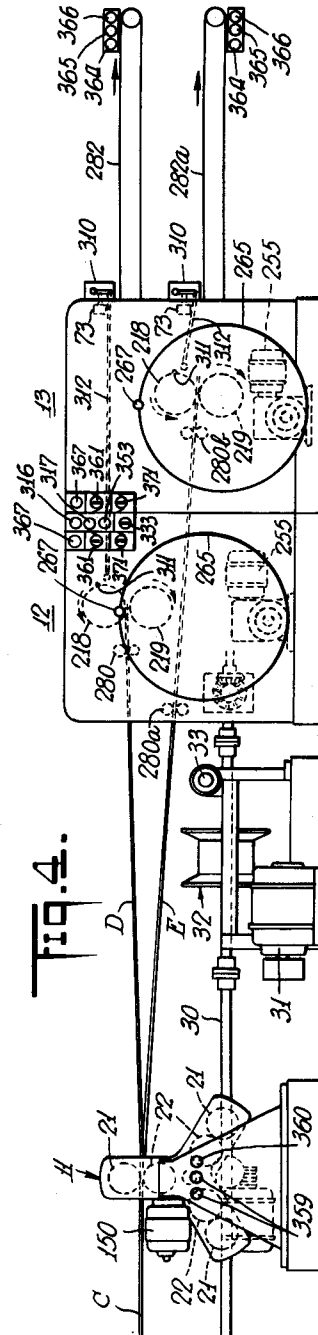
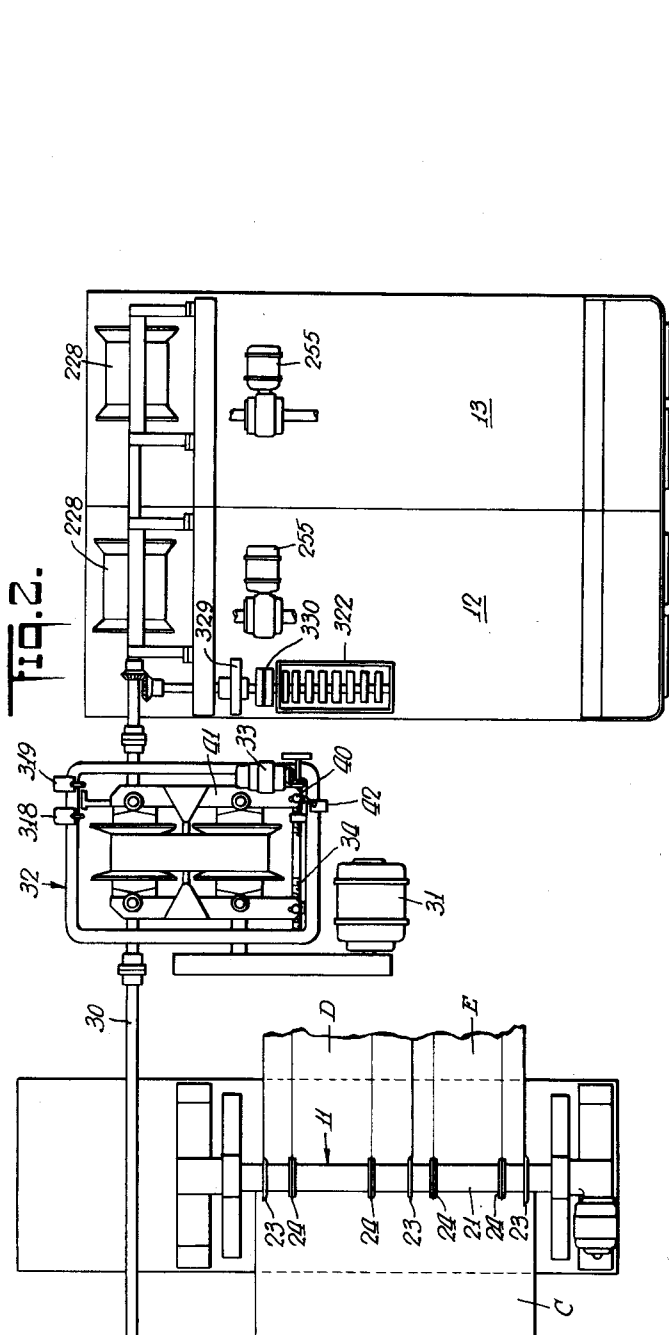
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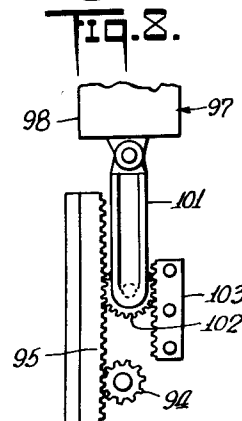
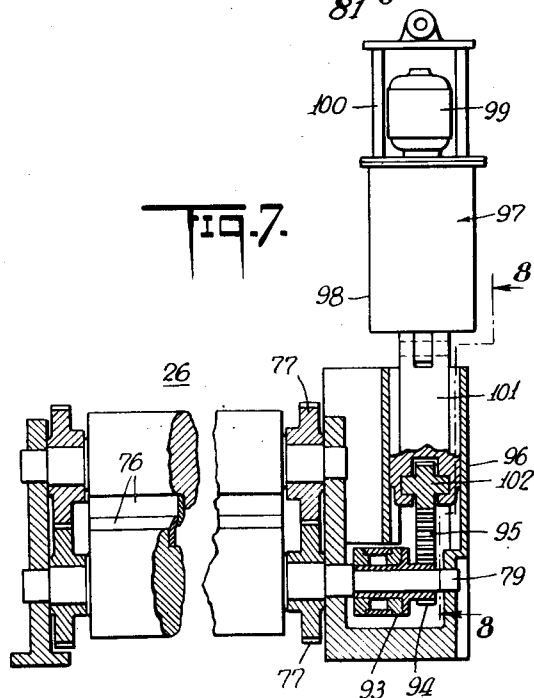
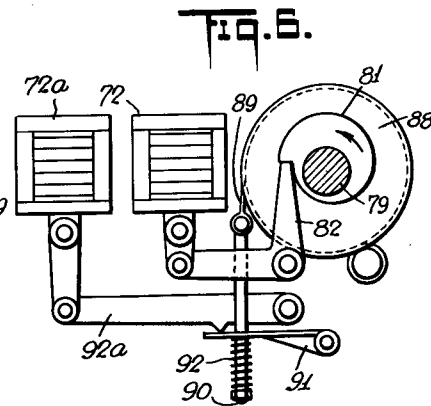
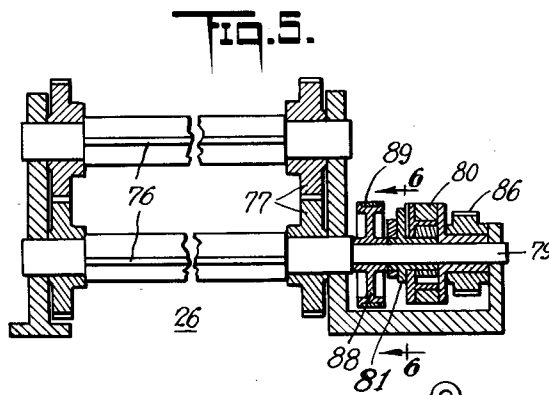
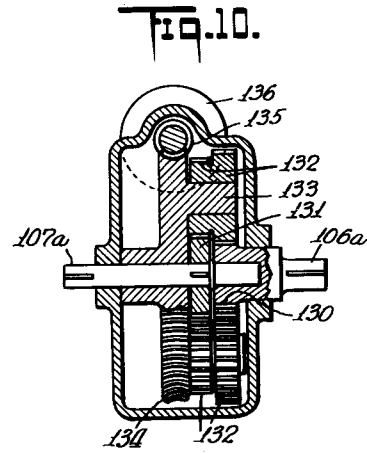
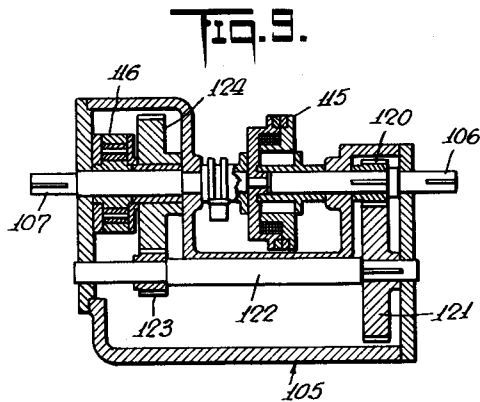
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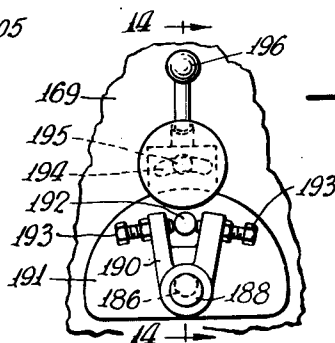
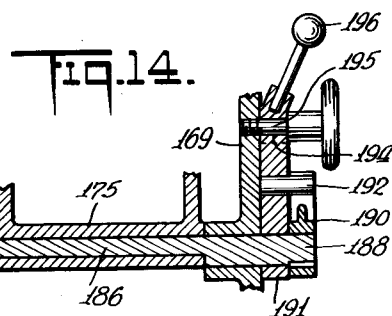
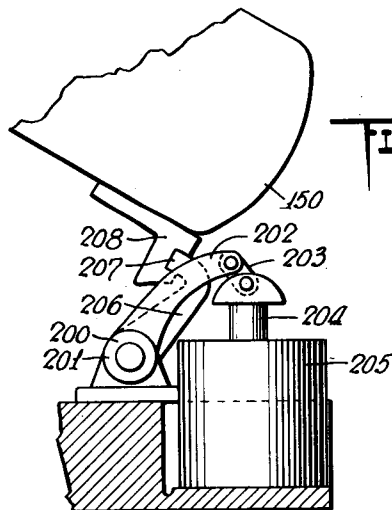
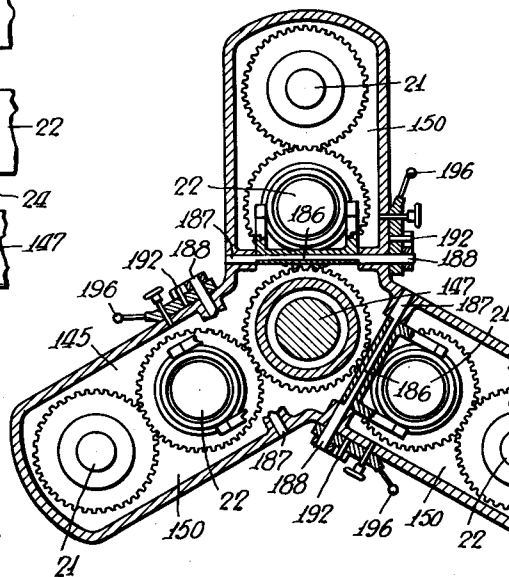


Fig. 13.

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Fig. 16.

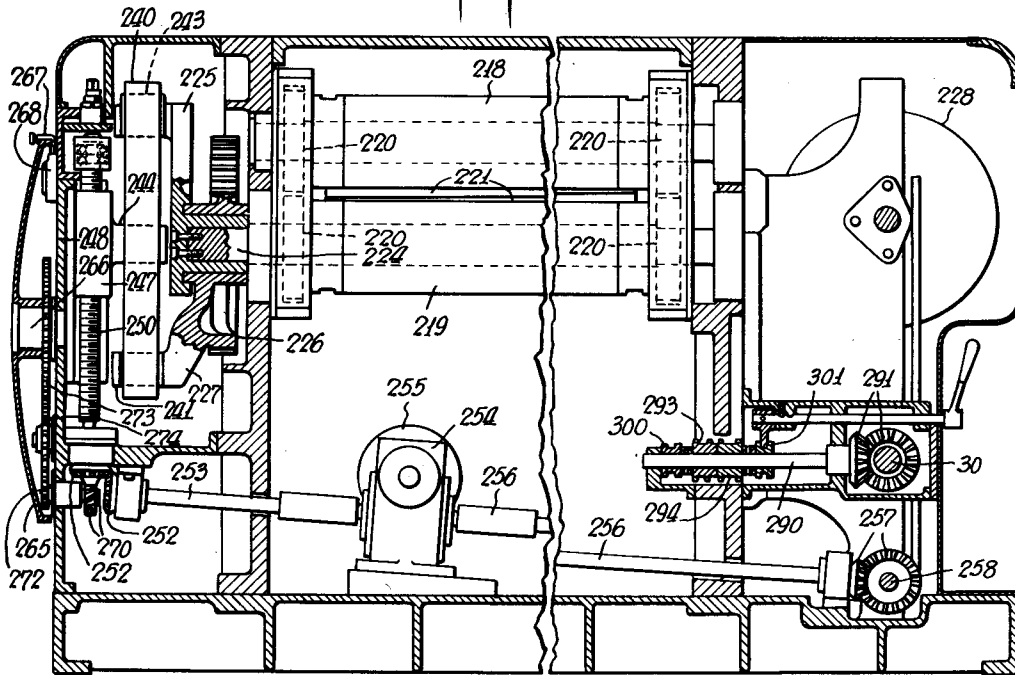


Fig. 11a

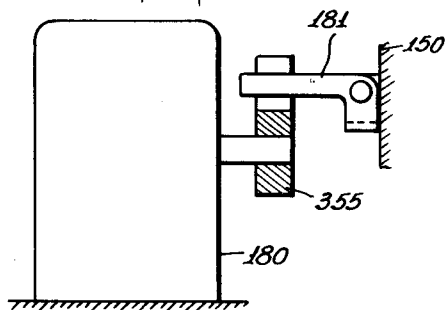
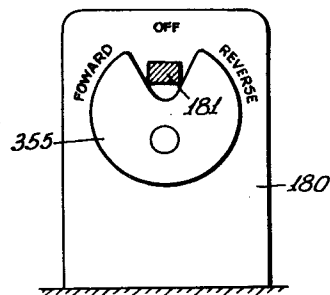


Fig. 11b



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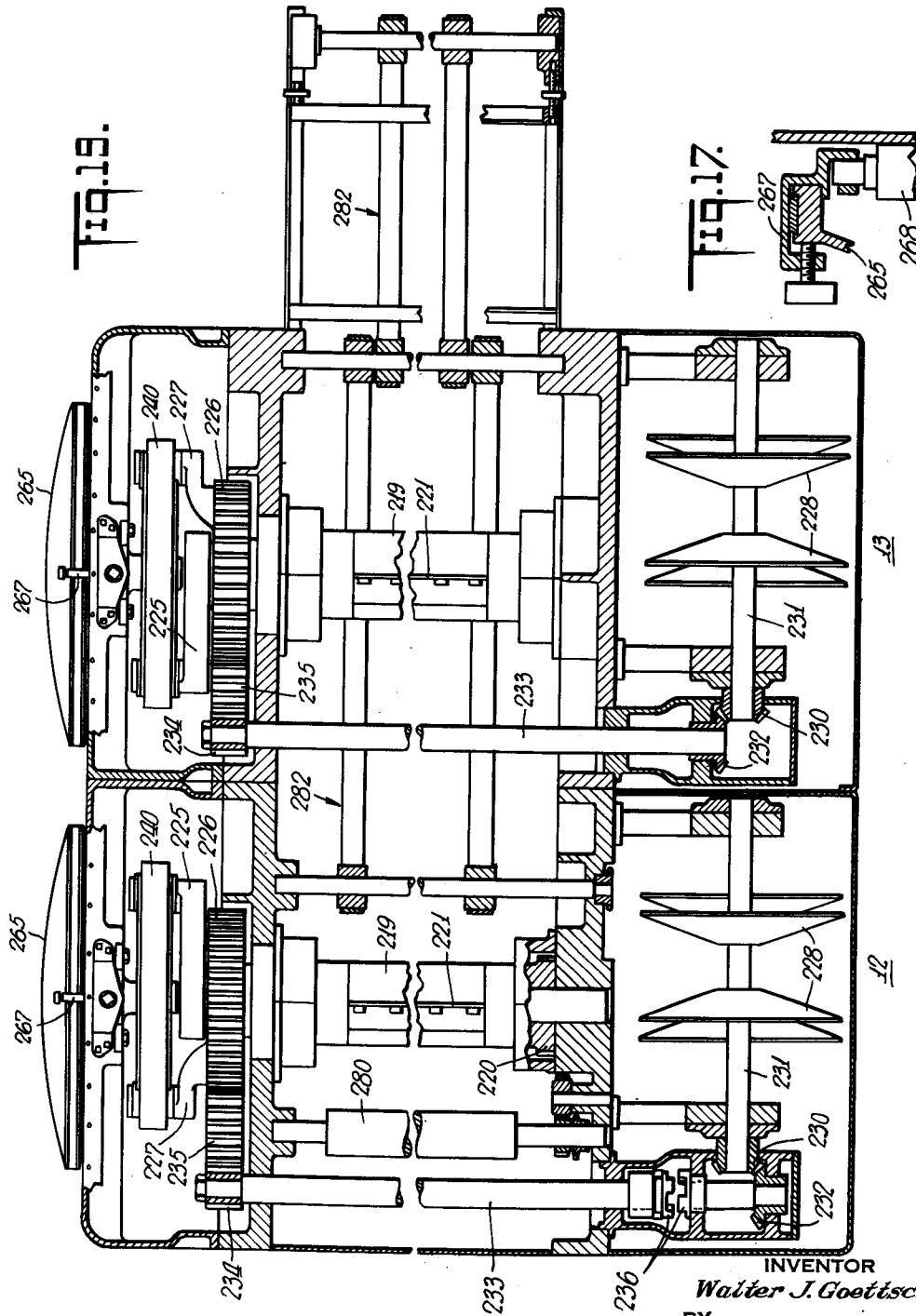
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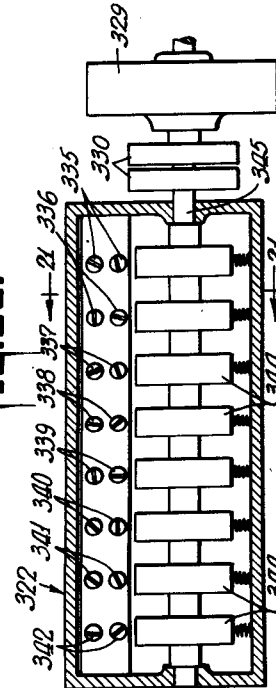
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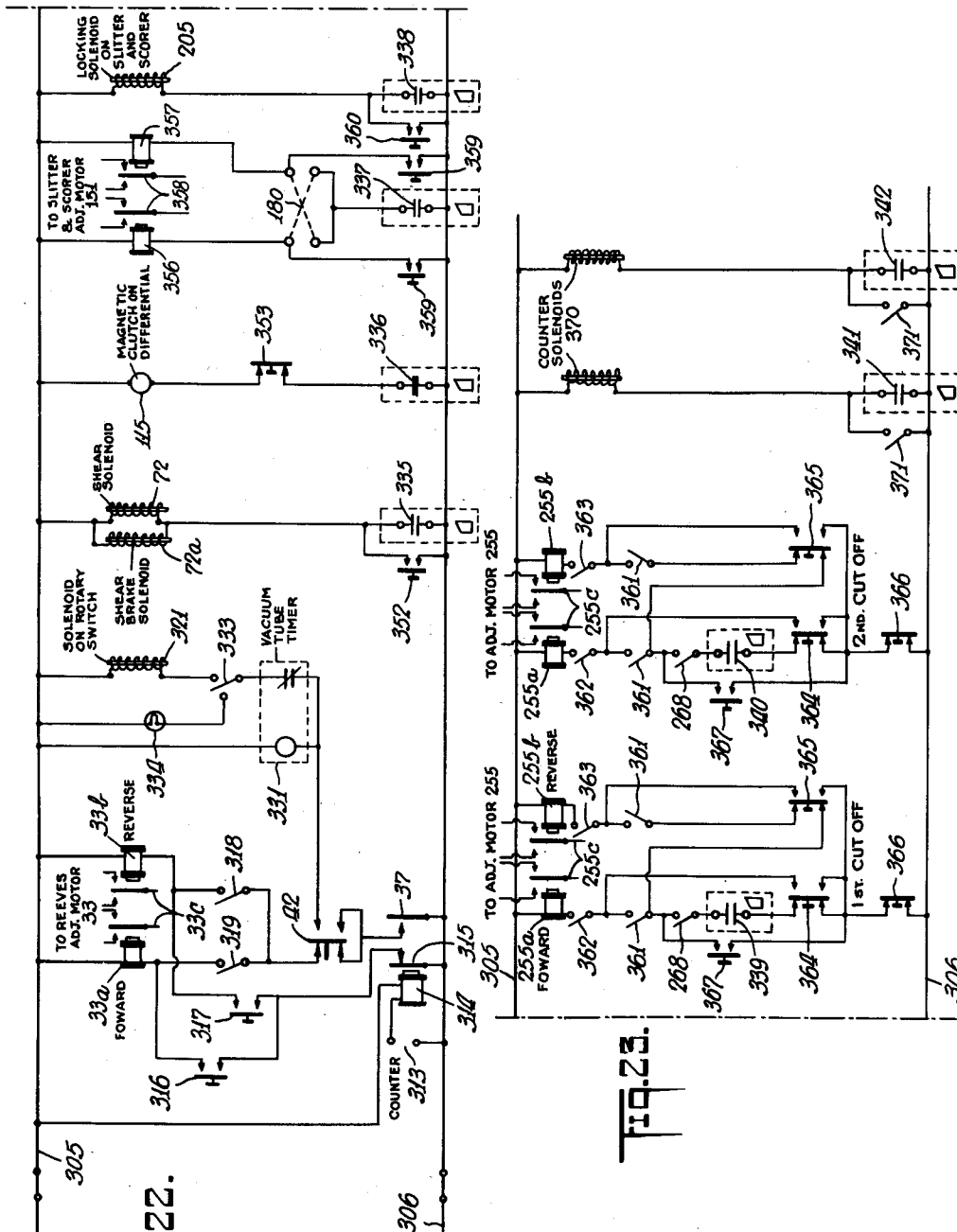


FIG. 23.

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2,309,728

PRODUCTION OF PAPER BOARD UNITS

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Application November 14, 1941, Serial No. 419,112

20 Claims. (Cl. 164—61)

In the manufacture of stiff sheet material, such for instance as double faced corrugated paper, the usual procedure is to operate the manufacturing unit, commonly called a double facer, at a substantially uniform speed, and to cut the delivered material into sheets, each of a length corresponding to one dimension, or a multiple of one dimension, of the blank to be used in making the final article, such for instance as a carton. The cutter travels at the same speed as the material at the instant of cutting, but its time cycle may be varied in order to cut the material into sheets of the desired lengths. The drive for the cutter is usually of the Reeves drive type, which cannot be readily adjusted when at rest and must be adjusted to vary the total time cycle in accordance with the length of the desired sheet. Therefore a change from a setting which cuts sheets of one length to a setting which cuts sheets of a different length must ordinarily be effected while at least the cut-off mechanism is running. A machine of that type is disclosed and claimed in the Sieg Patent 1,897,867 issued February 14, 1931.

If the adjustment be made while material is passing through, there are produced a considerable number of sheets, all of different lengths, and varying from approximately the length of the sheet being made before adjustment starts to approximately the length of the sheet to be made after the adjustment is completed; these being made during all of the period while the adjustment is being made from one setting to another. Of course the number of off-sized sheets will vary with the extent of adjustment and the time required. Obviously, it will be greater for changing for a 30" sheet to a 120" sheet than for changing from a 30" sheet to a 40" sheet. The trimming of these sheets to the shorter length required or to some other size results in considerable wastage, involves the labor and expense of the trimming and requires the use of a separate trimming machine.

To avoid this objection, the material may be cut in two at the delivery end of the double facer, the double facer stopped and the adjustment of the cutting mechanism made while the latter is running idle. In this case there is likewise considerable wastage due to the unsatisfactory character of the long portion of the sheet standing in the double facer while the latter is at rest and while adjustments of the cut-off mechanism are being made. This is due in part to the drying or setting of the adhesive which has been applied to one or more of the sheets on the way into the

double facer, so that these sheets are not satisfactorily secured together when they are later brought together and passed through the double facer. It may also be due to the overheating or baking of the portion of the material which is in the double facer while that portion of the machine is at rest.

No satisfactory means has heretofore been provided for avoiding the waste resulting from one or the other of the operating conditions above referred to.

The principal object of the present invention is to avoid the waste and objections above referred to, avoid the necessity of stopping the double facer during adjustments of the cut-off, and avoid the production of the off-size sheets ordinarily produced during the adjustment of the cut-off mechanism in changing from a setting for one sheet length to that for another sheet length. This object is accomplished in the present invention by a new method of operation which includes the cutting of the material in two at the delivery end of the double facer and permitting the double facer and the cut-off mechanism to continue running but at very substantially different rates of speed and with the double facer running at the slower speed. As a result, the portion of the sheet beyond the line of severance travels very much faster than the portion of the sheet in the rear of the line of severance and there is formed a gap of progressively increasing width between the two sections. The adjustment is made in the mechanism which requires to be adjusted for a different size of sheet, after the cut-off section has passed through said mechanism and before the slower traveling body of the material coming from the double facer reaches said mechanism. Thus the adjustment is made in the cut-off mechanism while no material is passing through said mechanism, but the progress of the body of the sheet through the double facer is not stopped and no material is spoiled on its way into, or while passing through the double facer. The only wastage comprises a single sheet produced from the portion which was cut in two at the delivery end of the double facer.

In different types of machines there may be a series of mechanisms which are disposed along the line of travel of the material and these may be changed or adjusted in succession as the gap between the cut-off portion and the body of the sheet progressively advances along the line of travel of the material through the successive portions of the complete machine.

If the material coming from the double facer

is to be trimmed and/or scored and/or slitted lengthwise into narrower strips, the necessary changes in the trimming, scoring and slitting mechanism may be effected after the cut-off section has left this part of the machine and while traveling to or through the cut-off mechanism which cuts it transversely into unit sheets, and before the advancing end of the material from the double facer has reached the trimming, scoring and slitting mechanism.

The adjustment of the cut-off mechanism may be made as soon as the cut-off section leaves that mechanism and while the advancing end of the body of the material is passing to and through the readjusted trimming, scoring and slitting mechanism. The sheet counter may be reset or a new one brought into position after the last sheet of one length leaves the cut-off mechanism and before the first sheet of the new length gets through the cut-off mechanism.

In order to facilitate the necessary adjustments or resettings, the trimming, scoring and slitting mechanism may include a plurality of operating units so that only one is in operative position at a time and another may have the position of its trimming, scoring and slitting elements adjusted to the new positions during the normal running of the machine. Thus all that is required to be effected in the gap between the advancing end of the material and the more rapidly advancing cut-off section, is the movement of one trimming, scoring and slitting unit out of operative position and the movement of another into position.

As a further feature of the invention, the various members for effecting the adjustments and changes may be automatically started in motion in the proper time sequence, and automatically stopped at the proper time so that when the cycle of changes has been made, the machine will produce the sheets of the new dimension as it continues operating.

As a preferred operation in carrying out the invention, all of the changes and adjustments are automatically controlled from the sheet counter at the delivery end of the machine. When a predetermined number of sheets of a given size have been delivered, the counter may close a circuit which operates a motor to adjust the variable speed drive of the entire machine and slow it down to a speed facilitating the making of the various adjustments in the required time interval, in case the machine was previously operating at a high speed. When the whole machine has been slowed down to a lower adjustment-facilitating speed, a circuit-closing and operation-timing mechanism is started in operation and this acts to initiate movement of the mechanisms for effecting the following and in some cases other successive operations:

1. Readjusting the variable speed drive of the entire machine to slow it down to a speed facilitating the making of the various adjustments in the required time interval.
2. Cutting the material in two at the delivery end of the double facer.
3. Bringing into operation suitable gearing which causes the double facer to operate at a lower speed than the other units which act on the material beyond the double facer.
4. Bringing the previously operating mechanism for trimming, slitting and scoring out of position and a new one into position.
5. Starting of the motor used for adjusting

the cut-off mechanism to give the desired sheet length.

6. Starting of a separate motor for adjusting the second cut-off mechanism, if two separate cut-off mechanisms are used to operate on separate strips into which the original material was slitted.

7. Restoring the driving connections whereby the double facer and the cutting mechanism again operate at the same speeds.

The mechanism and parts are so designed and operated that each of the adjusting movements is terminated when the required adjustment of movement has been effected and in accordance with previously set controls.

It will be understood that there may be a wide variation as to the details of various parts employed, and that in some machines there may be a larger or smaller number of parts or mechanisms which it is desirable or necessary to adjust or change when sheet length is to be changed. It will be also understood that so far as the broader aspects of the invention are concerned, many, if not all of the adjustments, substitutions or changes may be made manually instead of mechanically, and that even if done mechanically, the circuits of the operating motors may be closed and opened manually instead of automatically, provided of course that the proper timing be secured to carry out the method of the present invention.

Various other objects, features and advantages of the invention will be apparent from the following particular description, and from an inspection of the accompanying drawings, in which there are illustrated only a few of the many different mechanical constructions which may be employed in carrying out the invention.

Fig. 1 is a diagrammatic top plan view of the double facer forming part of the machine embodying the present invention.

Fig. 2 is a continuation of Fig. 1, and shows a diagrammatic top plan view of the slitter and scorer and cut-off mechanisms of the machine.

Fig. 3 is a diagrammatic side elevation partly in section of the double facer shown in Fig. 1.

Fig. 4 is a continuation of Fig. 3, and shows a diagrammatic side elevation of the slitter and scorer and cut-off mechanisms shown in Fig. 2.

Fig. 5 is a vertical section taken on the line 5-5 of Fig. 1 and showing a form of shear operating mechanism by which the travelling sheet is severed near the end of a run, preparatory to the making of adjustments for the next run.

Fig. 6 is a section taken on line 6-6 of Fig. 5.

Fig. 7 is a vertical section of another form of shear operating mechanism for severing the advancing sheet.

Fig. 8 is a diagrammatic view taken on line 8-8 of Fig. 7.

Fig. 9 is a vertical section taken on line 9-9 of Fig. 1 and showing a form of differential unit by which the speed of travel of the double facer is reduced in respect to that of the cut-off mechanisms.

Fig. 10 is a vertical section through another form of differential unit which may be used in place of that shown in Fig. 9.

Fig. 11 is a fragmentary vertical section through a slitter and scorer which may be used.

Fig. 11a is a side elevation of a cam switch controlling the operation of the adjusting motor of the slitter and scorer.

Fig. 11b is a front elevation of the switch shown in Fig. 11a.

Fig. 12 is a vertical section taken on line 12—12 of Fig. 11.

Fig. 13 is a side elevation of a portion of the slitter and scorer, on a larger scale.

Fig. 14 is a section taken on the line 14—14 of Fig. 13.

Fig. 15 is a side elevation of the automatic means for locking the rotatable frame of the slitter and scorer in proper rotative position.

Fig. 16 is a vertical section through one of the cut-off mechanisms.

Fig. 17 is a vertical section constituting an enlargement of a portion of Fig. 16.

Fig. 18 is a diagrammatic side elevation of the two cut-off mechanisms.

Fig. 19 is a horizontal diagrammatic section of the two cut-off mechanisms.

Fig. 20 is a longitudinal section of the rotary cam switch device by which the adjustments of the various mechanisms are automatically controlled in predetermined sequences and at predetermined intervals.

Fig. 21 is a section taken on line 21—21 of Fig. 20.

Fig. 22 is a portion of the wiring diagram of the automatic adjusting control system, and

Fig. 23 is the other portion of the wiring diagram forming a continuation of Fig. 22.

The adjusting system of the present invention is shown in Figs. 1 to 4 applied to a machine which includes a plurality of mechanisms operating on the material in succession. The first is a double facer 10 for applying a liner A to a single-faced corrugated sheet B to form a double-faced corrugated paper board C. Another is a slitter and scorer 11 to trim the edges of said board C and, if desired, to divide it longitudinally into strips of the desired width, and/or score it preparatory to the formation of some product, such as a box blank. Beyond the slitter 11 are one or more cut-off mechanisms 12 and 13 (two being shown) for cutting the slit strips D and E transversely into units, each of a length corresponding to one dimension or a multiple of one dimension of the blank to be used in making the final product.

The double facer 10 shown is of the usual type comprising an apparatus 15 for applying adhesive to the crowns of the corrugations of the single-faced corrugated sheet B as it is delivered from a roll or a single facer, a heater 16 for preheating the liner A as it is delivered from suitable roll stands, a heating section 17, and a pair of feed belts 19 and 20 on opposite sides of the sheet C for pulling it through and yieldingly pressing the layers together.

At the rear end of the double facer 10 is a shear mechanism 26 for severing the sheet C transversely when it is desired to make adjustments in the various mechanisms in preparation for the next run making a product of different size or other characteristics.

The slitter and scorer 11 is shown of the type disclosed and claimed in the Behrens Patent No. 2,291,789, issued August 4, 1942, and includes a plurality of pairs of shafts 21 and 22, each pair carrying pairs of opposed coacting slitting heads 23 and/or scoring heads 24, adjustable along said shafts in accordance with the width of the sheet, the width of the strips, if it is to be slitted, and the desired position of the score lines, if such are to be made. After one run has been completed with one pair of shafts in position, it is usually necessary to have a different adjustment of one or more of the pairs of the rotary heads

23 and 24 along their respective shafts 21 and 22, and sometimes necessary to change the number of these heads in preparation for the next run. Two or more slitting and/or scoring mechanisms are provided, each with its pair of coacting shafts 21 and 22, and so mounted that while one mechanism is in operative position and being used, another mechanism is in inoperative position where the adjustments may be made at leisure preparatory to moving it into operative position to replace the operating one at the end of its run.

The cut-off mechanisms 12 and 13 are shown of the type in which a pair of coacting knives come together at the instant of cutting, and travel with the sheet during cutting action at substantially the same speed as said sheet. In order to cut sheets of different length from each of the strips into which the sheet is slitted, the total time cycle of operation of each pair of knives is adjustable, while maintaining the speed of said knives at the instant of cutting constant and equal to the speed of travel of the sheet.

Although the cut-off mechanisms 12 and 13 are shown in the specific form as of the rotary type, as far as certain aspects of the invention are concerned these may be of any suitable travelling cut-off type such as that shown in Langston Patent No. 1,359,076.

As a feature of the present invention, the sheet C is cut by the shear mechanism 26 while said sheet is in motion. Immediately thereafter the speed of the rear severed portion which is in the double facer is reduced with respect to the speed of travel of the advance severed portion to form a gap of progressively increasing width between said sheet portions, so that the necessary time interval is provided to bring a new slitting and scoring set-up into line, and to reset the cut-offs 12 and 13 for the next run.

In normal operation the speed of the travelling paper C and the speed of operation of the various mechanisms of the machine may be so high that there is not sufficient time in which to make the adjustments, and therefore it is preferable that the speed of the entire machine be reduced before starting the making of adjustments.

The machine illustrated has a main drive shaft 30 (Figs. 1 to 4) for driving the various parts from a motor 31 through a variable speed drive 32, shown as a Reeves drive (Figs. 2 and 4), which may be adjusted to change the speed of the main shaft 30. Adjustment of the Reeves drive may be made by a reversible adjusting motor 33 having a drive connection to the adjusting screw 34 of said drive.

When a switch 37 (Fig. 22) in the circuit of the adjusting motor 33 is closed, the motor starts operating to turn the adjusting screw 34 until the speed of the main drive shaft 30 is reduced to that desired. Then an adjustable trip 40 (Fig. 2) on one of the adjusting levers 41 opens a limit switch 42 (Figs. 2 and 22) in the circuit of the variable speed adjusting motor 33, and thereby shuts off said motor. This limit switch 42 is positioned to reduce the speed of the travelling sheet and of the various mechanisms operating on said sheet to a suitable adjustment facilitating speed. In the case of a machine operating at a normal sheet speed of 400 feet per minute, the limit switch 42 is desirably positioned to reduce the sheet-speed about one half.

The next steps in the operation of the machine are to sever the sheet at the delivery end of the double facer and reduce the speed of the double

facer with respect to the other parts of the machine to provide the gap of progressively increasing width at the point of severance. Merely as an example of a severing means and operating mechanism therefor two forms are shown in Figs. 5 to 8. In Figs. 5 and 6 there is shown a pair of normally stationary rotary knives 76 connected at one end by a pair of intermeshing gears 77. The knives may be driven from the main drive shaft 30 of the machine through a suitable single revolution clutch 80 on the shaft 79 of one of the knives 76. That illustrated is of the well known Hilliard type. In this type of clutch, when the clutch is engaged, hardened rolls acting as wedges between the outer race or housing and flat surfaces on the inner hub transmit the drive from said outer housing to said inner hub to drive the shaft 79 which is keyed to said hub. A trip cam 81 is connected to a cage holding the rolls, and is normally held by a stop 82 as shown in Fig. 6, so that the rollers cannot engage and no power is transmitted. When the stop is moved outwardly, the cage with the rolls springs instantly into clutching position. When the stop again engages, the clutch is released and remains so as long as the trip cam 81 is held by the stop 82. When the clutch is to be engaged again, the stop 82 is again moved out.

The outer driving housing of the clutch 80 is driven from the main drive shaft 30, through a gear 83 (Figs. 1 and 3), and a gear 84 on the lower pulley of the feed belt drive 20 of the double facer 10, an idler gear 85, and a gear 86 rigid with said outer clutch housing.

During normal operations, the stop 82 is in the position shown in Fig. 6, so that the one revolution clutch 80 is disengaged and the rotary knives 76 are stationary. This stop 82 is shown in the form of a bell crank operated through a link from the spring-pressed plunger of the solenoid 72, which may have its circuit made and broken as hereinafter described. The energization of the solenoid 72 moves the core of the magnet downwardly so that it moves the stop 82 out of engagement with the trip cam 81, thereby effecting engagement of the clutch 80 and rotation of the two knives 76. As the two knives 76 come together, they sever the traveling web at paper speed.

The solenoid 72 is almost instantly deenergized before the shaft 79 of the lower knife 76 has completed one revolution, so that stop 82 is spring-pressed against the periphery of the trip cam 81 while said cam is completing its revolution. As soon as the catch section of the trip cam 81 reaches the stop 82, the clutch 80 will be disengaged and the knives 76 stopped in spaced position to permit passage of the sheet there-through.

A brake device may be provided to relieve the clutch 80 and the tripping mechanism of the shock involved in bringing the shaft 79 to an instantaneous stop, and to assure the maintenance of the knives 76 in predetermined stationary spaced position during normal operations. The Hilliard type of clutch is usually provided with a brake device which includes a brake drum 88 keyed to the shaft 79 and having a brake band 89, one end of which is anchored, while the other free end is secured to a rod 90 having a spring 92 on which is seated a lever 91. A pressure member 92a normally bears on the lever 91 while a solenoid 72a is deenergized, so that the weight of the core and the pressure member is

sufficient to tighten brake band 89 on the drum 88. When the brake solenoid 72a is energized simultaneously with the energization of the solenoid 72, the core of the solenoid 72a is pulled upwardly to lift the pressure member 92a, so that brake pressure on the drum 88 is correspondingly released to permit initial rotation of the knives 76. The brake solenoid 72a is deenergized at the same time as the solenoid 72, so that the brake is applied before the catch section of the trip cam 81 reaches the stop 82. The brake pressure on the drum 88 is not sufficient to prevent the two knives 76 from completing their one revolution. It should be noted that the knives speed up through about 90° of revolution, then cut, and then slow down to a stop in about 270° of revolution.

In Figs. 7 and 8 is shown another form of device which may be employed to drive the shear mechanism 26 through one revolution. In this form the drive is from an independent source of power rather than from the main drive shaft. The shaft 79 of one of the knives 76 has a standard type over-running clutch 93 with its hub keyed to said shaft and its outer housing fixed to a pinion 94. The pinion 94 meshes with a rack gear 95 slidable in a guide 96 to such an extent as will rotate the knives 76 one revolution. Any suitable means may be provided to reciprocate the rack bar. That shown is a General Electric Thrustor 97, which includes a centrifugal pump (not shown) enclosed in an oil chamber or tank 98 and operated from a motor 99. The pump creates pressure on one side of a piston (not shown) on which the tank 98 slides and which is connected to a fixed yoke 100. The tank is pivotally connected to a link 101 carrying a pinion 102, meshing with the slidable rack 95 and with a fixed rack gear 103. Thus, as the tank 98 is moved axially during operation of the motor 99, the pinion 102 travels down the rack 103 and moves the rack 95 down at twice the speed to rotate the pinion 94 in a direction to engage the overrunning clutch 93, and thereby rotate the knives 76 one revolution. The return movement of the tank 98 with respect to the yoke 100 may be effected by a suitable spring while the knives 76 remain stationary. A stop lever and brake arrangement (not shown) similar to that shown in Fig. 5 is desirably provided to stop the knives 76 always in the same position with little or no shock.

As previously noted, the double facer has its speed reduced as soon as the knives 76 have operated to sever the sheet, while the advance severed portion is permitted to continue its travel at a faster speed. This may be accomplished by means of a differential which may be brought into and out of operation. A suitable form is shown in Fig. 9 in which an input shaft 106 has a drive connection from the main drive shaft 30, and an output shaft 107 coaxial therewith has a drive connection to the sheet feed drive 19 and 20 of the double facer 10 through gears 83 and 84.

A magnetic clutch 115 between the input and output shafts 106 and 107 is normally engaged, so that said shafts are locked for rotation at the same speed. For reducing the speed of the output shaft 107 with respect to the input shaft 106 when the magnetic clutch is released, there is provided an overrunning clutch 116 in series with a speed reduction unit including a pinion 120, keyed to said input shaft, a larger gear 121 affixed to a shaft 122 having a pinion 123 meshing

with a larger gear 124 driving one clutch element of the overrunning clutch 116.

During normal operations, while the two shafts 106 and 107 are rotating at the same speed, the inner clutch element overruns the outer clutch element which is being driven at a slower speed through the gearing 120, 121, 123 and 124.

When the magnetic clutch 115 is disengaged, so that drive to the output shaft 107 will be entirely through the speed reduction gearing 120, 121, 123 and 124, and through the overrunning clutch 116, said output shaft will be rotated at a greatly reduced speed. This will cause a reduction in the speed of travel of the rear severed portion of the sheet C with respect to the speed of travel of the advance severed portion to such an extent as to allow sufficient time to adjust the slitter and scorer 11 and the cut-offs 12 and 13 before the forward end of the rear severed portion of the sheet C reaches said mechanisms.

In Fig. 10 is shown another form of differential, which may be used in place of that shown in Fig. 9 for reducing the speed of the double facer 10. In this construction the input shaft 106a and the output shaft 107a have coaxial gears 130 and 131, both meshing with one or more sets of gears 132 journaled on studs 133 carried by a worm wheel 134, supported for rotation about the axis of the shafts 106a and 107a, and meshing with a worm 135 which may be driven from a motor 136. The worm wheel 134 is normally stationary, so that power is transmitted from the input shaft 106a to the output shaft 107a through gears 130, 132 and 131 and the shafts rotate at predetermined relative speeds. When the motor is rotated to rotate the worm wheel 134, the output shaft will be driven faster or slower depending on the direction of rotation of the motor. When it is desired to reduce the speed of the double facer to any desired extent, the motor 136 is rotated in the proper direction. The amount of reduction is determined by the speed of the motor. Obviously a wide variety of other speed reducing mechanisms may be employed in place of either of the two illustrated. In some respects, it is preferable to employ some modification of the ordinary automobile differential.

Merely as an example of a slitter and scorer 11, there has been shown in Figs. 11-14 one of the triplex type, which is shown and described in the aforementioned Behrens Patent No. 2,291,789. This particular form includes three duplicate pairs of coacting shafts 21 and 22, all mounted on a rotatable frame having end sections 145 (only one being shown) secured to a normally stationary central shaft 147. Thus any one of said pairs can be brought directly above the axis of said frame in operative position upon rotation of said central shaft and said frame. These end frame sections 145 have three radiating arms 150 spaced 120° apart for supporting the end bearings of the shafts 21 and 22.

Each pair of shafts 21 and 22 have rigidly but adjustably secured thereto the desired number of slitting and/or scoring members 23 and 24 for acting on the sheet as it passes therebetween. For instance there may be a pair of coacting slitting heads for trimming the margins of the advancing sheet to give it straight edges and a desired width, any desired number of pairs of coacting slitting heads for subdividing the sheet longitudinally in strips of the desired width and number, and if desired, any required number of pairs of scoring heads for creasing the sheet to

provide fold lines. Each pair of rotary heads 23 or 24 is mounted for adjustment along the shafts 21 and 22 to properly locate longitudinal scores and slits in the advancing sheet.

For rotating the shaft 147, there is provided a motor 151 having a drive connection to the shaft 147 through a reduction gearing, comprising a worm 152 on the motor shaft, and a worm wheel 153 splined to said shaft and meshing with said worm. The motor 151 is reversible, so that the frame 145 may be rotated in either direction to move one or the other of the other pairs of shafts 21 and 22 and their slitting and scoring heads into operative position. The starting, stopping and direction of rotation of the motor is controlled as hereinafter described.

For rotating the shafts 21 and 22 when they are in operative position, there is provided a central drive gear 155, which is rotatably supported on shaft 147, and rigidly connected to a gear 161 by a sleeve 162. The main drive shaft 30 has a bevel gear 157, which meshes with a bevel gear 158 carrying a spur gear 160 meshing with the gear 161.

Each pair of shafts 21 and 22 has a pair of intermeshing gears 165 and 166, the radially inner gear 166 having a hub on which a gear 168 is rotatably supported and meshes with the drive gear 155. The coaxial gears 166 and 168 are disconnected by a clutch 170, these parts being in a housing or cover part 169.

For automatically operating the clutch during the rotation of the frame arm 150 associated therewith, there is provided a collar 173 movable axially along the shaft 22 by means of a fixed cam 174, and a bell crank 175. The cam 174 is secured to a fixed frame part of the machine, and its eccentric annular face groove 176 receives one arm 177 of the bell crank 175, while its other arm 178 in the form of a shifter fork extends in an annular peripheral groove of the collar 173. The part of the groove directly above the shaft 147 is spaced further from the axis of said shaft than are other parts of the groove. Thus, when any one of the slitting and scoring mechanisms nearly reaches operative position in the rotation of the shaft 147 and frame 145, the end of the bell crank lever 175 in the cam groove 176 is pushed radially outwardly to engage the clutch 170, and as said mechanism leaves operating position, the end of said lever 175 is pulled inwardly to disengage the clutch 170. The gears 166 and 168 will therefore be coupled for rotation in unison, and the drive between the drive gear 155 and the shafts 21 and 22, which are uppermost, is established. The two other clutches 170 associated with the two operative pairs of shafts 21 and 22 in inoperative position are disengaged, so that no driving of these shafts while in these positions will normally take place, and they may be freely rotated if necessary while adjusting the heads 23 and 24 lengthwise thereof.

For automatically breaking the circuit of the motor 151 when any pair of shafts 21 and 22 is brought to operative position, a stationary frame part of the machine carries a motor stop switch 180, which is operated by a pawl 181 carried by each of the radiating frame arms 150 as will be more fully described.

While the upper pair of shafts 21 and 22 with their associated trimming, slitting and scoring heads 23 and 24 are operating on an advancing sheet, the operator may be axially adjusting the slitting, trimming and scoring heads 23 and 24 on one of the lower inactive pairs of shafts 21

and 22. In this way the operator can be preparing the two lower pairs of shafts 21 and 22 for the next two succeeding runs.

To permit testing of the adjustments on the two lower inactive pairs of shafts 21 and 22 without interfering with the operation of the upper operative pair of shafts 21 and 22, and to permit adjustment of the clutch 170 to compensate for any wear in the clutch plates thereof, the bell crank 175 is supported on a spindle 185 journaled in the side sections of the associated cover 169 as shown in Fig. 14. An intermediate section 186 of this spindle 185 loosely embraced by the hub of the bell crank 175 is reduced in diameter, and is eccentrically disposed with respect to the end sections 187 and 188. An end section 188 projects outwardly beyond one of the sides of the frame cover 169, and has keyed or otherwise secured thereto a U-shaped yoke 190. A plate 191 is supported for oscillation on the projecting end 188 of the spindle, and carries a pin 192, which extends between the two arms of the yoke 190, and is engaged by adjusting screws 193 threaded in said arms respectively. This plate 191 is provided with a segmental slot 194, through which extends a locking screw 195 threaded into the side of the cover 169. A handle 196 is secured to the plate 191 for rotating the plate 191 a limited extent about the spindle section 188.

When it is desired to adjust the bell crank 175 to compensate for wear in the friction plates of the clutch 170, the adjusting screws 193 are turned to rotate the spindle 185, and thereby move the axis of the bell crank 175 with respect to the axis of the spindle ends 187 and 188. This adjustment will cause the plates of the clutch 170 to be brought closer together.

When it is desired to test the position of the trimming, slitting and scoring heads 23 and 24 on the lower inactive shafts 21 and 22, the locking screw 195 is loosened, and the plate 191 oscillated to turn the spindle 185 about the axis of its end sections 187 and 188. This will swing the bell crank 175 into position to engage the clutch 170, so that the inactive shafts 21 and 22 being tested will be driven. A test sheet can then be run between the inactive rotating shafts 21 and 22 to check the accuracy of the adjusted positioning of the slittings and scorings.

The worm 152 and worm wheel 153 form an irreversible drive which cannot rotate except through operation of the motor 151. This serves to automatically lock the frame 145 against rotation when the motor is stopped with the frame in any one of its three angular operative positions.

In order to further assure the locking of the frame 145 in proper position, and in order to relieve the strain on the gears resulting from the pulling action of the traveling sheet through the machine, there may be provided a latch comprising crank 200 pivotally supported at 201, and having one arm 202 connected by a link 203 to the spring-pressed armature plunger 204 of a solenoid 205. The other crank arm 206 is provided with a finger 207 adapted to extend into a slot of a catch 208 secured to the outer end of each of the radiating frame arms 150. When the solenoid 205 is energized, the finger 207 moves out of locking engagement with the catch 208, so that the radiating arms 150 are permitted to rotate. Immediately after release of the catch 208, and after the radiating arms 150 have started to rotate, the solenoid 205 is automatically deenergized in a manner to be described, so that the crank 200 is rotated in position to extend the finger 207 into

the catch 208 opposite to said finger as soon as the radiating arm 150 carrying said catch reaches its new lower inoperative position.

The cut-off mechanisms 12 and 13 shown in Figs. 2, 4, and 16 to 19, may be of the general type disclosed and claimed in the Behrens Patent No. 2,262,913, issued November 18, 1941, and each comprises a pair of rotary cutter heads or drums 218 and 219 mounted for rotation about horizontal parallel axes, and connected together at one or both ends by intermeshing gears 220 to rotate said drums in opposite directions. The two cutter heads 218 and 219 are provided with the respective knives 221, which coact to cut into sections the slit and scored sheet passing between the oppositely rotating cutter heads.

One of the cutter heads, as for instance the lower head 219 (see Fig. 16) has its shaft 224 fixed to a crank arm 225. Rotatable on the hub of this crank arm 225 is a drive gear 226 having rigid therewith a crank arm 227, which is rotated at constant speed from a variable speed unit 228, shown as a Reeves drive (Fig. 19) having its input shaft connected to the main drive shaft 30. The drive connection from this variable speed unit 228 comprises a bevel gear 230 on the output shaft 231 of said unit meshing with a bevel gear 232 on a shaft 233, which latter carries a gear 234 driving the gear 226 through an idler gear 235. A clutch 236 in the shaft 233 of the first cut-off 12 serves to disengage said cut-off at will from the main drive in case it is desired to operate only the second cut-off 13.

The input shaft 237 of the Reeves drive 228 of the first cut-off 12 (Fig. 18) is connected at one end to the main shaft 30, and at the other end to the input shaft 237a of the Reeves drive 228 of the second cut-off 13. A clutch 238 between the two input shafts 237 and 237a permits disengagement of the second Reeves drive 228, in case it is desired to operate only the first cut-off 12.

Power is transmitted from the crank arm 227 to the crank arm 225 through a lever arm 240, journaled on the crank pin 241 of the crank arm 227, and provided with a guide slot extending lengthwise thereof for receiving the crank pin 243 of the crank arm 225, and the adjustable pivot support 244 about which the lever arm 240 swings. In the position shown in Fig. 16, the adjusting pivot 244 is in axial alignment with the drum shaft 224, so that the two crank arms 225 and 227 and the two cutter drums 218 and 219 rotate at the same constant angular velocity.

For moving the adjustable pivot 244 radially of the axis of the drum shaft 224, said pivot is connected to a crosshead 247 mounted to slide in a stationary frame member or guide 248 extending along the diameter of the drum 219. This crosshead 247 is threaded on a screw shaft 250, so that the pivot may be moved vertically and in a radial direction with respect to the shaft 224.

The screw shaft 250 is normally stationary, so as to hold the pivot 244 in a predetermined adjusted position. In order to bring this pivot 244 to any degree of eccentricity in respect to the shaft 224, there is provided a mitre gear connection 252 between the screw shaft 250 and a shaft 253 driven through a speed reduction gear unit 254 from an adjusting motor 255. A shaft 256 driven by the same speed reduction unit 254 has a mitre gear connection 257 with the adjusting screw 258 of the Reeves drive 228. Thus when the adjusting motor 255 is driven, the Reeves

drive 228 is adjusted to vary the total time cycle of the two cutters 221, and thereby vary the length of sheet cut. At the same time, the position of the adjustable pivot 244 will be correspondingly adjusted to keep the cutter speed at the instant of cutting the same as the speed of sheet travel.

It will be understood that in adjusting a Reeves drive, one pair of bevel pulleys are brought toward each other and the other pair are separated, the two pairs being connected by a belt. As these features are well known in the art, the belts and the pulley adjusting means are not illustrated in Figs. 16, 18 and 19. They might be similar to what is indicated in Fig. 2.

In order to predetermine the extent of rotation of the adjusting motor 255 in accordance with the preselected length of sheet to be cut, there is provided on each of the cut-offs a disc 265, journaled onto a stub shaft 266 fixed to a frame part of said cut-off, and calibrated to indicate different sheet length. The disc carries an adjustable preselector clamp 267 on the rim thereof for engaging a fixed limit switch 268 in the circuit of the adjusting motor 255, which switch is adapted to be tripped by the preselector clamp 267 to open the circuit of said motor, and thereby shut off said motor when the proper adjustments corresponding to the next size of sheet to be cut has been made.

The disc 265 is rotated during the adjustment of the cut-off mechanism by a worm and worm wheel drive 270 connecting the adjusting screw 250 to a shaft which also carries a gear 272, driving a gear 273 on the disc 265 through an idler 274.

The two cut-offs 12 and 13 are disposed one behind the other, with their paper feed devices and cutting heads arranged at different levels, so that as the sheet is slit by the slitter scorer 11, the two strips D and E are separated vertically, the upper section D travelling, for instance, through the first cut-off 12, while the lower section travels through the second cut-off 13. The path of the two strips is indicated by double dotted lines in Figs. 4 and 18.

The paper feed includes a pair of feed rolls 280 interconnected by a suitable gear train for feeding the upper sheet section D between the knives 221 of the first cut-off 12, and a second pair of similar feed rolls 280a interconnected by a gear train for feeding the lower sheet section E towards the knives of the second cut-off 13. A third pair of feed rolls 280b support the sheet section E and assist in feeding said sheet section between the knives of the second cut-off 13. A belt conveyor 282 on the outlet side of the cutters of the first cut-off conveys the cut sheets to a suitable stacker. A similar belt conveyor 282a is disposed on the outlet side of the cutters of the second cut-off 13.

In order to drive the various feed rolls and conveyors at suitable peripheral speed, the main drive shaft 30 drives a shaft 290 through a mitre gear connection 291. Connected to the shaft 290 are two sets of sprocket wheels 293 and 294. One of these sets has sprocket chain drives 295 and 296 to the gear train of the feed rolls 280 and the drive wheel of the conveyor 282 respectively of the first cut-off mechanism 12, while the other set has sprocket chain drives 295a and 296a to the gear train of the feed rolls 280a and a shaft 297 respectively of one of the feed rolls 280b. A chain drive 298 from this shaft 297 drives the conveyor 282a of the second cut-off 13.

Clutches 300 and 301 between the two sets of drive sprocket wheels 293 and 294 respectively and the shaft 290 permit disengagement of the drive to the feed devices associated with either cut-off in case it is desired to operate only one cut-off mechanism.

As noted in the introductory portion of this specification, the present invention does not reside in the details of construction of any of the units hereinbefore described, as each of said units may, if desired, be of a type heretofore designed by others or well known in the art. The present invention involves a control and a novel and important timing of the operation of these units, so that novel and important results are obtained. In theory, such timing and control might be effected by the operator who would have to open and close the circuits of the various control motors and solenoids in the proper sequence, but from a practical standpoint this would be difficult. Therefore, as a further important feature of the invention, the control is effected automatically and by mechanism which may be readily adjusted in accordance with the length of the sheets to be cut and the number of sheets desired of each length, width and other characteristics.

The adjusting mechanism is so designed that while one run is being made, the operator may preset the controls for the next run, so that as the first run is completed, all of the adjusting motors or other operating mechanisms are brought into operation in the desired sequence and each actuated in the desired direction and to the desired extent. As a result, it is not necessary to stop the double facer or to adjust any part acting on the material leaving the double facer, while said material is passing through the part being adjusted. All adjustments are made after severance of the sheet and in the gap interval between the slower moving and faster moving part of the material.

The control may be effected automatically by various different means, that hereinafter described being merely one example.

Each of the cut-offs 12 and 13 is provided with a preset counter 310 (Figs. 4 and 22), which may be operated by the sheet, but which is preferably operated through a suitable mechanism from the knife cylinders to record the number of revolutions thereof, and therefore the number of sheets cut. For instance, a projection 311 (Fig. 4) on one of each pair of cooperating knife cylinders trips a rod 312 connected to the counter lever of a respective counter 310.

The predetermined counters 310 are of any suitable well-known construction, such as that of the Veeder-Root high speed type No. G-37-54 shown in U. S. Patents Nos. 2,040,025, 2,040,026, 2,040,027 and 2,159,314, and carry two sets of dials or figures with one set of figures subtracting and one set of figures adding at each stroke of the counter operating lever. During the period while the machine is idling and adjustments are being made for changes in the sheet cut, the operator manually sets the counter 310 at zero on one set of dials and sets up a series of numbers on the second set of dials corresponding to the number of sheets to be cut for the next order. This presetting of the latter set of dials automatically opens a switch 313 (Fig. 22) in the corresponding counter 310, and when the desired number of sheets have been cut and zero has been reached by said dials by the successive subtractions of the counter operating lever as de-

scribed, said switch is automatically closed to energize a relay coil 314, which controls switches 37 and 315, and which is one of many control circuits extending in parallel between power lines 305 and 306 as will be described. Although there is only one counter switch 313 shown, there may be two of these switches, one for each counter 310, connected together in parallel and connected in series with the relay 314, or there may be only one switch 313 operated from either counter.

Both of the relay switches 37 and 315 are in respective parallel circuits in series with the main drive Reeves adjusting motor 33. While the relay coil 314 is deenergized, the switch 315 is closed and the switch 37 is opened as shown in Fig. 22. A pair of switches 316 and 317 desirably of the push-button type and desirably mounted on the cut-offs 12 and 13, control the forward and reversing sides respectively of the Reeves adjusting motor 33, and allow the operator to manually change the speed of said motor to give either a forward or reverse motion to said motor with the consequent increase or decrease in speed of the main drive. The main drive Reeves 32 can be manually controlled through the switches 316 and 317 only as long as the switch 315 is closed.

The Reeves adjusting motor 33 may be directly in the control circuit described, or said circuit may be provided with a pair of relays 33a and 33b controlling a switch 33c in the power circuit of said motor 33. According to the operation of the control switches 316 and 317 either relay 33a or 33b is energized to cause flow of current through either the forward or reverse side of motor 33, and thereby cause corresponding rotation of said motor.

When the operator manually changes the speed of the main drive Reeves by the operation of either switch 316 or 317, either limit switch 318 or 319 in the circuit of the switch 37 is tripped by the lever on the Reeves drive 32, thereby automatically setting the proper rotation of the adjusting motor 33 (forward or reverse), so that the Reeves speed will be brought down or up to the proper speed for automatic operation.

Since the proper direction of rotation of the adjusting motor 33 has been set by the closing of either limit switch 318 or 319 as described, the energization of the relay coil 314 when the subtracting set of dials on the counter 310 reach zero at the end of a run will open the switch 315 and close switch 37, thereby allowing the current to flow to either the forward or reverse side of the Reeves adjusting motor 33, and bringing the main drive to the proper speed, at which time the limit switch 42 (Figs. 2 and 22) is operated by the trip 40. This causes interruption of the current to the adjusting motor 33, and thereby stops said motor. When the limit switch 42 is tripped, it opens a circuit of the Reeves adjusting motor 33, and at the same time closes the circuit of a solenoid 321 controlling a timing device 322 (Figs. 2, 20, 21 and 22).

The timing device 322 controls the adjustments of the various mechanisms in predetermined sequences and at predetermined intervals, and is driven from the main drive shaft 30 through a drive connection including a suitable speed reducer 329 and a suitable one-revolution clutch 330, such as that of the Hilliard type previously described in connection with the shear device 26 of Figs. 5 and 6. The closing of the circuit of the solenoid 321 by the tripping of the limit switch 42 as described, releases the

trip cam (not shown) of the clutch 330 in a manner similar to that indicated with reference to Figs. 5 and 6, and thereby causes engagement of said clutch so that the timing device 322, desirably in the form of a rotary limit switch, rotates one revolution in a predetermined number of seconds and then stops.

In the control circuit of the solenoid 321, there is desirably a vacuum tube timer 331, which holds the circuit closed for a predetermined number of seconds and then breaks the circuit before the trip cam has completed one revolution. The stop lever (not shown) is thereby returned to latch the trip cam upon completion of its one revolution.

The vacuum tube timer 331 may be of any suitable well-known construction, such as that of the General Electric type CR7504-A3A, and will not operate through its cycle until the sequences of the preceding switches described has been repeated.

In the control circuit of the solenoid 321 is also desirably provided a selector switch 333 located at the cut-offs 12 and 13 for closing or opening the circuit whereby the operator may cut out the automatic timing on the machine. A suitable lamp 334 may be provided to indicate the condition of the selector switch 333.

The rotary limit switch device 322 may be of any suitable construction, such as that of the General Electric type CR9503-206-B, and comprises a series of switches 335, 336, 337, 338, 339, 340, 341 and 342, operated at predetermined intervals to control different stages of adjustment. These switches are operated by respective cams 344 on a shaft 345 which is driven from the main drive shaft 30 through the speed reducer 329 and the one-revolution clutch 330 as previously described.

In Figs. 20 and 21 the rotary limit switch device 322 is shown of the type in which a pair of trips or dogs on each of the cams 344 opens and closes its corresponding switch as said trips rotate into predetermined position. As an example, this construction is shown with the two trips in different planes. One trip 347 strikes a roller of a spring-pressed lever 348 to swing the latter and thereby close the contacts of the switch. A latch 350 engages the lever 348 to temporarily lock it in contact closed position as shown. Another trip 351 on the cam kicks out the latch 350 against the action of a compression spring acting on said latch, and lets the spring-pressed lever 348 move in switch open position.

The switch part shown in Fig. 21 is for the control of the magnetic clutch 115 (Fig. 9) by which the speed of the double facer is reduced. The circuit of this clutch 115 is normally closed while the machine is on production and is opened by the cam action of the rotary switch device 322. In the case of the differential motor 136 in the construction of Fig. 10, the cam switch contacts would be normally open, and would be closed by the corresponding cam on the rotary switch device 322. The contacts on the rotary switch device 322 may be normally closed or normally opened depending on which trip acts on the member 348 and 350 for normal setting.

The time required for the cam shaft 345 to make one revolution, and the relative angular positions of the switch-operating trips on the cams of the rotary switch device 322 are fixed according to the distances between the successive mechanisms to be adjusted and the speed of

the material. It must be understood that this time element and relative positioning of the switch operating trips should suit the particular installation, and that those set forth in the following description are given merely as an example of an installation in which the shear 26 is spaced twelve feet from the slitter scorer 11 and twenty-four feet from the first cut-off 12 and in which the paper travels at a maximum speed of about 480 feet per minute.

As soon as the cam shaft 345 starts rotating, the first trip on the first cam 344 closes switch 335, and thereby closes the circuit of the solenoids 72 and 72a in the shear driving device shown in Figs. 5 and 6, or closes the circuit (not shown) of the motor 99 in the shear driving device shown in Figs. 7 and 8. This causes the knives of the shear 26 to rotate one revolution, and to thereby sever the paper at the double facer 10.

The switch 335 is held closed for about 3° of rotation of the cam control shaft 345 when a second trip on the corresponding cam 344 opens said switch and thereby deenergizes the solenoids 72 and 72a.

The circuit of the solenoids 72 and 72a is desirably provided with a switch 352 of the push-button type shunted across the contacts of the cam switch 335 and located at the shear device 26 to permit manual operation and control of said shear device.

Desirably about 6° after start of rotation of the cam shaft 345, the switch 336 is opened by the first trip on the corresponding cam 344. This switch 336 opens the circuit of the magnetic clutch 115 in the construction of Fig. 9, so that the speed of the double facer 10, and in turn the speed of the rear severed portion of the sheet is reduced. In the alternative construction of Fig. 10, the cam 344 closes the circuit of the differential motor 136, so that the worm 134 is rotated to effect reduction in the speed of the double facer. In case the alternative construction of Fig. 10 is used, the switch 336 may be in the circuit of a relay (not shown), which closes the contacts in the circuit of the differential motor 136. In that case, the latter circuit would not be part of the control circuit.

Desirably about 294° after the start of rotation of the cam shaft 345, the switch 336 is closed by the second trip on the corresponding cam 344, thereby permitting the magnetic clutch 115 in the construction of Fig. 9 to engage, or is opened to stop the motor 136 in the alternative construction of Fig. 10. Thus the speed of the double facer 10 is restored to that of the slitter and scorer 11 and of the cut-off mechanisms 12 and 13. During the interval of rotation of the cam shaft 345 between 6° and 294°, during which time the double facer is operated at reduced speed, a new set-up of the slitter and scorer 11 and of the cut-offs 12 and 13 is automatically effected as will be described.

The control circuit of the magnetic clutch 115 is desirably provided with a switch 353 of the push-button type located on the cut-offs 12 and 13 to permit the manual operation or control of said clutch. In the case of the differential motor 136 in the alternative construction of Fig. 10, this switch 353 would be connected across the cam switch 336.

Desirably about 12° after start of rotation of the cam shaft 345, the switch 337 controlling the operation of the motor 151 of the slitter and scorer 11 is closed by the first trip on the cor-

responding cam 344. This automatically brings a new set of adjusted slitting and/or scoring heads 23 and 24 into operative position.

The switch 337 is opened by the second trip on the corresponding cam 344 about 180° after start of rotation of the cam shaft 345, thereby operating the motor 151 for sufficient time to move any one of the two lower pairs of slitter and scorer shafts 120° into upper operative position.

The switch 180 (Figs. 11a and 22) controls the direction of rotation of the motor 151 and the stopping of said motor when the slitter and scorer 11 reaches a new operative position. This switch may be of the cam reversible type, such as that of General Electric CR3300-BG-3A, and has a shaft carrying a small slotted cam 355 which is located outside the casing of the switch. The operator lifts the pivoted pawl 181 out of the cam slot and manually turns the cam 355 either into forward or reverse position, so that the switch 180 is set to cause rotation of the motor 151 either in a forward or reverse direction when the rotary cam switch 337 is closed. As the pawl 181 located on the respective frame arm 150 of the slitter and scorer is moved upwardly into operative position through the operation of the motor 151, this pawl engages the cam 355 and rotates its into neutral or off position to open the switch 180, and thereby stops the motor 151.

The motor 151 may be directly in the control circuit described, or said circuit may be provided with a pair of relays 356 and 357 controlling a switch 358 in the power circuit of the motor 151. According to the setting of the switch 180, either relay 356 or 357 is energized to cause flow of current through either the forward or reverse side of the motor 151, and thereby cause corresponding rotation of said motor.

A pair of by-pass switches 359 of the push-button type are desirably located on the slitter and scorer to permit manual adjusting operation thereof in either direction.

At the same time that the cam switch 337 is closed about 12° after start of rotation of the cam shaft 345, the cam switch 338 in the control circuit of the slitter and scorer locking solenoid 205 is closed, and is again opened after the cam shaft 345 has rotated a few degrees from the opening position of said switch to effect locking of the slitter and scorer when it reaches its new operative position, as has already been described. A by-pass switch 360 desirably of the push-button type and located on the slitter and scorer permits manual control of the locking solenoid 205.

The operation of the adjusting motor 255 of the first cut-off 12 is controlled by the cam switch 339, while the operation of the adjusting motor 355 of the second cut-off 13 is controlled by the cam switch 340. The cam switch 339 is closed about 21° after start of rotation of the cam shaft 345, and is opened about 201° after start of rotation of said shaft, thereby operating the first adjusting motor 255 for sufficient time to adjust the first cut-off 12. The cam switch 340 is closed about 24° after start of rotation of the cam shaft 345, and is opened about 204° after start of rotation of said shaft to operate the other adjusting motor 255, and thereby adjust the second cut-off 13. The three degrees phase difference in the operation of the two cam switches 339 and 340 compensates for the horizontal distance between the cutting planes of the two cut-offs.

The adjusting motor 255 may be directly in the control circuit described, or said circuit may

be provided with a pair of relays 255a and 255b controlling a switch 255c in the power circuit of said motor. According to the operation of certain control switches to be described, either relay 255a or 255b is energized to cause flow of current through either the forward or reverse side of the motor 255, and thereby cause corresponding rotation of said motor.

In the operation of the preselector device on the cut-offs, the operator during the run when the machine is on production, moves the preselector clamp 267 on the scale of the discs 265 to a position corresponding to the next size of sheet to be cut, and also sets a reversing selector switch 361 on the cut-off for either forward or reverse rotation of the corresponding adjusting motor 255. The setting of the reversing switch 361 depends on whether the next size of sheet to be cut is to be shorter or longer than the size of the sheet being cut.

The closing of the rotary cam switch 339 and 340 closes the circuits of the corresponding adjusting motors 255, allowing the current to flow to either the forward or reverse side of said motors depending on the setting of the reversing switches 361. As the motor 255 adjusts the sheet length of the corresponding cut-off, it also simultaneously turns the disc 265 on which the preselector clamp 267 has been previously set by the operator. As this disc 265 rotates, it brings the preselector clamp 267 into contact with the limit switch 268, thereby breaking the circuit and stopping the motor 255.

The cut-off control circuit is also desirably provided with limit switches 362 and 363 which will break the circuit after the adjusting motor 255, through any cause, should tend to overrun the limits of the machine adjusted. Each of the cut-off control circuits is desirably provided with additional switches 364 and 365 of the jog latch button type, located at a corresponding conveyor 282 or 282a. These switches 364 and 365 allow the operator to manually jog the motor 255 for minute adjustments which might be required for exact sheet length due to any inaccuracy in the original setting of the preselector clamp 267 on the disc 265.

A stop switch 366 desirably of the push-button type, and located at its corresponding conveyor 282 or 282a permits shut-down of the control of the corresponding cut-off, and a by-pass switch 367 desirably of the push-button type and located at said cut-off permits manual control of the adjustment in said cut-off.

Immediately after the high speed paper section has passed through the second cut-off 13, the counters 310 are automatically disengaged, so that they do not operate during the time interval when no paper is passing through the cut-offs. For that purpose solenoids 370 on respective counters 310 are energized by automatic closure of the cam switches 341 and 342 about 24° after start of rotation of the cam shaft 345, to disengage the counter shafts from the mechanisms operating said counters, and thereby render said counters inoperative. As soon as the slower-moving sheets enter the cut-offs, the adjusting cycle has been completed. At that time the cam switches 341 and 342 are automatically opened by the corresponding cams 344 to deenergize the solenoids 370, so that the counters 310 are rendered operative for the next run. The cam switches 341 and 342 are opened about 312° after start of rotation of the cam shaft 345. Just before opening of the cam switches 341 and

342 about 294° after start of rotation of the cam shaft 345, the magnetic clutch 115 of the differential shown in Fig. 9 is engaged, or the motor 136 of the alternative differential shown in Fig. 10 is stopped, so that the speed of the double facer is stepped up to conform with the speed of the slitter and scorer 11 and the cut-offs 12 and 13.

Both of the control circuits of the counter solenoids 370 are desirably provided with by-pass selector switches 371 located on the cut-offs for manual operation.

During the period while the machine is idling and adjustments are being made, the operator manually sets the counter 310, which has completed its run, at zero on one set of dials and sets up a series of numbers on the second set of dials corresponding to the number of sheets to be cut for the next run. This re-setting of the counter 310 automatically closes the switch 313, so that the relay coil 314 is deenergized, and the switches 37 and 315 are opened and closed respectively. The operator then manually operates the switches 316 or 317 to adjust the Reeves drive 32, so that the speed of the drive shaft is restored to its desired normal operating value, and the switch 316 or 317 tripped so that the Reeves drive 32 is set to rotate the adjusting motor 33 in the proper direction when the counter switch 310 is automatically closed at the end of a production run.

Although the operation of the machine is believed apparent from the foregoing description, it is herein briefly summarized. Assuming that the manufacturing unit is running at a maximum speed corresponding to a sheet speed of about 480 feet per minute, which speed may at the present time be a little higher than is found practical in commercial production, and assuming that the cut-offs 12 and 13 are each cutting sections of predetermined length, the operator moves the preselector clamps 267 to that section of the scale of the discs 265 indicating the desired sheet length for the next run. At the same time, the operator sets the reversing switches 180 and 361 to set the slitter and scorer adjusting motor 151 and the cut-off adjusting motors 255 for rotation in the proper direction at the proper time. Also, the operator sets on each of the counters 310 a group of figures representing the number of sheets desired to be cut by the respective cut-off. When this number has been reached by the counter, contact 37 therein is automatically closed to set the variable speed adjusting motor 33 into operation, so that the speed of the machine is reduced from a production speed of about 480 feet per minute to a speed of about 240 feet per minute. When the reduced machine speed has been attained, the limit switch 42 is tripped to engage the one revolution clutch 330 between the main shaft 30 and the cam shaft 345 of the rotary control switch device 322, and thereby cause rotation of said cam shaft through a single revolution in a predetermined number of seconds. As soon as this cam shaft 345 starts its one revolution, the switch 335 is automatically closed to engage the one revolution clutch on the shear device 26, thereby revolving the knives of said device one revolution, and severing the paper at the double facer 10. Immediately upon the completion of this severing operation, switch 336 is automatically opened, so that the magnetic clutch 115 in the differential shown in Fig. 9 is disengaged, or is closed in the alternative construction of Fig. 10 to start rota-

tion of the differential motor 136. This causes the speed of the double facer 10 to be reduced.

The switch 337 in the control device 322 is next closed, putting the slitter and scorer adjusting motor 151 in motion, thereby rotating the radiating arms 150, the proper direction of rotation of said motor having been previously set by the operator by operation of the reversing switch 180.

The two switches 339 and 340 are next closed, putting the two cut-off adjusting motors 255 into operation in their proper sequence relative to the paper passing through the cut-offs, thereby adjusting the variable speed drives 228 to change the total time cycles of their cutters 221 to suit the desired sheet length, and simultaneously adjusting the position of the pivot 244 to change the speed of said cutters in various parts of their cycle, so that they will cut the web at paper speed. Simultaneously, the disc 265 on each cut-off is rotated until preselector clamp 267 thereon strikes the limit switch 268, thereby stopping its associated adjusting motor 255. The proper direction of rotation of this disc 265 is previously set by the operator through proper setting of the reversing switch 361.

The switches 341, which have been previously closed to render the counters 310 inoperative after the fast moving sheet has left the cut-offs, are opened after adjustments in said cut-offs, to effect reengagement of said counters. Switches 316 or 317 are then manually closed to adjust the Reeves drive 32 to its normal setting, so that the manufacturing unit is restored to its original operating speed.

Assuming, for example, that the running speed of the paper is reduced to 240 feet per minute or 4 feet per second by adjustment of the Reeves drive 32, and that the distance between the cutter 26 on the double facer 10 and the slitter and scorer 11 is 12 feet, and the distance between said slitter and scorer and the first cut-off 12 is also 12 feet, then the edge of the advance severed section of the paper will clear said cut-off in six seconds. Assuming that the speed of the rear severed section of the paper has been further reduced to a speed of 30 feet per minute or $\frac{1}{2}$ feet per second, the leading edge of said section would take 24 seconds to reach the slitter and scorer, thereby allowing ample time for said slitter and scorer to be rotated into operative position. It would also take about 24 seconds for this leading edge to travel from the slitter and scorer 11 to the first cut-off 12, thereby allowing 24 seconds for adjustment of said cut-off and other operations of the cycle. Due to the overlapping of certain adjustments of the cycle, the six seconds required to clear the high speed section of the paper from the cut-offs is not important, especially since the clearance time of 42 seconds is more than ample for the various adjustments. If, therefore, the control shaft 345 on the switch device is timed to revolve in 48 seconds between the beginning and the end of the cycle, ample adjusting time will be afforded.

A certain amount of slip takes place in the slitter and scorer 11 during the interval when the oncoming web of paper is running at the reduced speed of 30 feet per minute therethrough, although said slitter and scorer is attempting to pull this at 240 feet per minute. The slip clutch between the main shaft 30 and the shaft of the slitter and scorer 11 permits this slippage. This slippage is not sufficient to cause tear or damage to the web, and in the case of

the light weight material, the scoring elements 24 are not crushed into the material firmly enough to cause such damage.

Although adjustment of the Reeves drive 32 has been described as a preliminary step in the adjusting cycle to reduce the speed of the entire manufacturing unit, as far as certain aspects of the invention are concerned this preliminary step can be eliminated, especially in cases where it might not be desirable to alter the original setting of said drive.

Although certain novel features of the invention have been shown and described and are pointed out in the annexed claims, it will be understood that various omissions, substitutions and changes in the several steps of the method and in its operation and in the form and details of the apparatus illustrated may be made by those skilled in the art without departing from the spirit of the invention.

What is claimed is:

1. The method of continuously producing stiff sheet material while changing from the production of severed sheets of one size to the production of severed sheets of a different size, said method including the following steps (1) severing sheet at the delivery end of the producing mechanism (2) reducing the speed of travel of the advancing body of material with respect to the speed of the severed portion to thereby form a gap of progressively increasing width between the supply and severed portions (3) adjusting the cut-off mechanism to cut sheets of a different length after the severed portion has passed the cut-off mechanism and before the slower moving body portion reaches said cut-off mechanism and (4) restoring the producing mechanism and the cut-off mechanism to the same operating speed.

2. A method of reducing the production of intermediate sizes of sheets during adjusting, from the production of sheets of one selected size to the production of sheets of a different selected size, said method comprising the steps of severing the advancing sheet material at a section rearwardly of the rearmost mechanism, reducing the speed of travel of the portion of the sheet material at the rear of the line of severance with respect to the speed of travel of the portion of the sheet material in advance of said line of severance, while continuing the advancing movements of said portions to form a gap of progressively increasing width therebetween, and adjusting said mechanisms in succession during the intervals determined by said gap when no sheet material is advancing through said mechanisms.

3. A method of minimizing waste of material during the change from cutting sheets of one length to cutting sheets of a different length, which comprises the steps of materially reducing the speed of travel of the sheet material to a low speed, severing the advancing sheet material between the point of production and the point of cut-off, thereafter further reducing the speed of production with respect to the frequency of the cutting operation, to thereby leave a gap of progressively increasing width between the severed sections, changing the total time cycle of said cut-off unit during the time interval while no sheet material is travelling therethrough, but while sheet material is being continuously produced, and thereafter reestablishing the same operating speed for the producing and cutting.

4. The method of reducing waste in the producing and subdividing of double faced corru-

gated board into sections and while adjusting the cut-off mechanism to cut off sections of a different length, which method includes automatically severing the material at the delivery end of the producing unit, when a predetermined number of sections of a selected length have been cut, then reducing but not stopping the speed of production of the sheet material with respect to the speed of travel of the portion of the sheet material beyond the line of severance, to thereby form a gap of continuously increasing width between the sections, and to afford a substantial interval between the time the faster travelling portion leaves the cut-off unit and the slower travelling portion reaches said unit, changing the time cycle of operation of said cut-off unit during said interval, and thereafter reestablishing the same speed of operation for the producing and cut-off units.

5. In the continuous production of stiff sheet material by means of a double facer, and the cutting thereof into sheets of a predetermined length by means of a cut-off mechanism having its time cycle of operation adjustable to cut sheet sections of different lengths, the method which includes cutting the advancing sheet material transversely at the delivery end of the double facer, thereafter operating the double facer and cut-off mechanism at different speeds, the latter operating the faster to thereby form a gap of progressively increasing width between the two portions, changing the time cycle of said cut-off mechanism before the slower travelling portion of the sheet material reaches said cut-off mechanism, and thereafter operating the double facer and the cut-off mechanism at the same speed.

6. In the continuous production of stiff sheet material, and the cutting thereof into sheets of a predetermined length, which includes the steps of continuously producing and advancing the sheet material, cutting the advancing sheet transversely at a point beyond the producing mechanism and at a substantial distance rearwardly of the cut-off mechanism, reducing the speed of production of the sheet with respect to the speed of travel of the advance severed portion of the sheet material, to form a gap of progressively increasing width between the two portions, adjusting the time cycle of operation of said cut-off mechanism after the faster travelling portion of the sheet material passes through said cut-off mechanism, and before the slower travelling portion of the sheet material reaches said cut-off mechanism, and thereafter restoring the producing mechanism and the cut-off mechanism to the same operating speeds.

7. In the method of continuously producing and slitting advancing sheet material to make strips of predetermined widths, the improvement involving the changing over to the making of strips of other widths without interrupting the continuous production of the material, which comprises the steps of cutting off the advancing sheet material transversely at a section rearwardly of the point of slitting, reducing the speed of travel of the portion of the sheet material at the rear of the line of severance with respect to the speed of travel of the portion of the sheet material beyond said line of severance, while continuing the advancing movement of said portions at different speeds, to form a gap of progressively increasing width between the two portions, and changing the positions of the slitter during the time interval between the egress of the faster travelling portion

from the slitter and the ingress of the slower travelling portion in to said slitter.

8. In the slitting and scoring for continuously advancing sheet material, the method which comprises the steps of cutting the advancing sheet material transversely, reducing the speed of travel of the portion of the sheet material at the rear of the line of severance with respect to the speed of travel of the portion of the sheet material beyond said line of severance, while continuing the advancing movement of said portions at different rates, to form a gap of progressively increasing width between the two portions, moving the slitting and scoring mechanism out of the path of movement of the advancing sheet material, and another mechanism having a different relative spacing of slitting and scoring elements into said path of movement after the faster moving portion of the sheet material moves beyond the field of operation of said mechanism, and before the slower moving portion of the sheet material reaches said field of operation, and thereafter restoring the slower moving portion of the sheet material to its original speed.

9. In the method of adhesively applying a paper lining to continuously advancing corrugated paper, and cutting the resulting board transversely into sheets of predetermined length, the improvement which comprises the steps of cutting off the advancing board transversely between the place where the board is made and the place where it is cut into sections, changing the relative speeds of travel of the rear severed portion of the board and the speed of travel of the advance severed portion, so that the latter travels faster, while continuing the advancing movement of said portions to thereby afford a substantial interval between the time the faster travelling portion leaves the cut-off mechanism and the slower travelling portion reaches said cut-off mechanism, and adjusting the cut-off mechanism during said interval to cut sheets of different length.

10. In the continuous production of sheets of double faced corrugated board of predetermined length, the method of changing over to the production of sheets of a different length, which includes the steps of cutting off the sheet transversely between the producing mechanism and the cut-off mechanism, reducing the speed of travel of the rear severed portion of the sheet with respect to the speed of travel of the advance severed portion to afford a substantial interval between the time the faster sheet portion leaves the cut-off mechanism and the slower travelling sheet portion reaches said cut-off mechanism, and adjusting the total time cycle of the cut-off mechanism during said interval.

11. In the continuous production of comparatively stiff sheets of predetermined width and length, the method of changing over to a different width and length with the minimum waste of material, which includes the steps of continuously advancing the sheet material, cutting it transversely when approximately the desired number of sheets of one size have been made, reducing the speed of travel of the rear severed portion of the sheet material with respect to the speed of travel of the advance severed portion to form a gap of progressively increasing width between the two portions, moving a slitter to the desired position for sheets of the different width during the interval between the time the faster portion of the sheet material leaves the field of operation of said

slitter and the time the slower travelling portion reaches said field of operation, adjusting the time cycle of a cut-off mechanism to that required for sheets of the different length during the interval between the time the faster portion of the sheet material leaves the field of operation of said cut-off mechanism, and the slower portion reaches said last-mentioned field of operation, and thereafter increasing the speed of travel of the rear severed portion.

12. A method of continuously producing and advancing a double faced corrugated sheet, said method comprising the steps of cutting the sheet transversely between said double facer and said slitting device, reducing the speed of travel of the rear severed portion of the sheet with respect to the speed of travel of the advance severed portion, while continuing the advancing movement of said portions to form a gap of progressively increasing width between the two portions, and adjusting said slitting device laterally in respect to the sheet and said cut-off mechanisms to change the time cycle during the interval determined by said gap, and when no material is passing through said device and said mechanisms.

13. A machine for making stiff sheets of a preselected dimension, including a mechanism for continuously producing and advancing the sheet material, a cutting mechanism for acting on said material and adjustable to give said dimension, means for severing said sheet material transversely at a section rearwardly of said cutting mechanism, means for thereafter reducing the speed of the producing and advancing mechanism with respect to the speed of the cutting mechanism, to form a gap of progressively increasing width between the two advancing portions, means for adjusting said cutting mechanism in the interval between egress of the advance severed portion of the sheet material from said field of operation and ingress of said rear severed portion into said field of operation, and means for thereafter restoring the speed of said producing and advancing mechanism to that of the cutting mechanism.

14. A machine for making stiff sheets of a preselected length, including a mechanism for continuously producing and advancing the sheet material, a cut-off mechanism for cutting the advancing material into sheets, and adjustable to give the preselected length, means operable when a predetermined number of said sheets have been cut off, for severing said sheet material transversely between said mechanisms, means operable thereafter for reducing the speed of the producing and advancing mechanism with respect to the speed of the cut-off mechanism, to thereby form a gap of progressively increasing width between the two advancing portions, and to afford a substantial interval during which no sheet material is passing through said cut-off mechanism, and means operable during said interval for adjusting the time cycle of operation of said cut-off mechanism to cut sheets of a different preselected length.

15. A machine for making stiff sheets of a preselected length, including a mechanism for continuously producing and advancing the sheet material, a cut-off mechanism for cutting the advancing material into sheets, and adjustable to give the preselected length, means automatically operable when a predetermined number of said sheets have been cut off, for severing said sheet material transversely between said mechanisms, means automatically operable thereafter

for reducing the speed of the producing and advancing mechanism with respect to the speed of the cut-off mechanism, to thereby form a gap of progressively increasing width between the two advancing portions, and to afford a substantial interval during which no sheet material is passing through said cut-off mechanism, and means automatically operable during said interval for adjusting the time cycle of operation of said cut-off mechanism to cut sheets of a different preselected length.

16. A machine for making stiff sheets of a preselected size, including a mechanism for continuously producing and advancing stiff sheet material, a mechanism for cutting the material lengthwise, a travelling cut-off mechanism for cutting said material transversely into sheets, said mechanisms being arranged to operate in succession on the advancing material, means operable when a predetermined number of said sheets of a preselected size have been cut off, for severing the advancing sheet material transversely between said first and second mechanisms, means operable thereafter for reducing the speed of travel of said first mechanism with respect to the speed of said second and third mechanisms to form a gap of progressively increasing width, means for thereafter adjusting said second and third mechanisms in predetermined sequence and during the intervals determined by said gap when no sheet material is advancing through said mechanisms, and means for thereafter restoring all of said mechanisms to the same operating speed.

17. A machine for making stiff sheets of a preselected size, including a mechanism for continuously producing and advancing stiff sheet material, a mechanism for cutting the material lengthwise, a travelling cut-off mechanism for cutting said material transversely into sheets, said mechanisms being arranged to operate in succession on the advancing material, means automatically operable when a predetermined number of said sheets of a preselected size have been cut off, for severing the advancing sheet material transversely between said first and second mechanisms, means automatically operable thereafter for reducing the speed of travel of said first mechanism with respect to the speed of said second and third mechanisms to form a gap of progressively increasing width, means for thereafter automatically adjusting said second and third mechanisms in predetermined sequence and during the intervals determined by said gap when no sheet material is advancing through said mechanisms, and means for thereafter restoring all of said mechanisms to the same operating speed.

18. In combination, a double facer for continuously producing and advancing double faced corrugated board, a travelling cut-off mechanism for cutting said board transversely into sections of predetermined length during the advancing movement, means between said double facer and said cut-off mechanism, and automatically operable when a predetermined number of sheets have been cut by said cut-off mechanism, for severing said board transversely, means automatically operable thereafter for reducing the speed of the double facer with respect to the speed of the cut-off mechanism to thereby form a gap of progressively increasing width between the two advancing portions of material, and to afford an interval during which no sheet material is passing through said cut-off mechanism,

and means automatically operable during said interval for adjusting the time cycle of said cut-off mechanism to cut sheets of different length.

19. In combination, a double facer for continuously producing and advancing double faced corrugated board, a plurality of slitting and/or scoring mechanisms for slitting and/or scoring the advancing sheet material longitudinally, said mechanisms being movably mounted to permit any one of said mechanisms to be moved into or out of operative position with respect to the advancing board, means automatically operable when a predetermined amount of said sheet material has passed through the field of operation of an operative one of said mechanisms to sever said sheet material transversely at a section rearwardly of said mechanism, means automatically operable thereafter for reducing the speed of the double facer with respect to the speed of the advance severed portion to form a gap of progressively increasing width between two advancing portions, and means automatically operable after the advance severed portion moves beyond the field of operation of the operative one of said mechanisms, and before the rear advance portion has reached said mechanism for moving the operative mechanism out of operative position, and another mechanism into operative position.

20. In combination, a continuously operating double facer, a slitting device for slitting the sheet material delivered from said double facer longitudinally into strips, a pair of cut-off mechanisms for transversely cutting the separate strips into sections of predetermined length, means at the delivery end of the double facer and automatically operable when a predetermined number of sections have been cut by one of said cut-off mechanisms, for severing said sheet material transversely, means automatically operable thereafter for reducing the speed of the double facer with respect to the speed of the advance severed portion to form a gap of progressively increasing width between the two advancing portions, means automatically operable during the interval determined by said gap when no sheet material is passing through said slitting device for adjusting said device to change the position of the slitting line with respect to the edges of the advancing sheet material, and means automatically operable during the interval determined by said gap when no sheet material is passing through said cut-off mechanisms for adjusting the time cycles of operation of said cut-off mechanisms.

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