Aug. 29, 1961 G. T. SCHJELDAHL ET AL 2,997,889

INTERMITTENT ENGINE

Filed Dec. 24, 1956 2 Sheets-Sheet 1

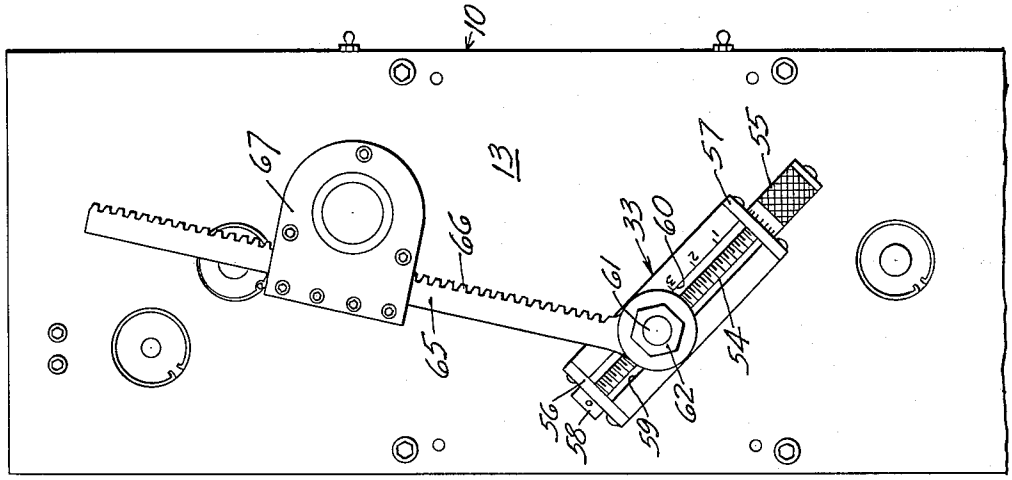


FIG. 2

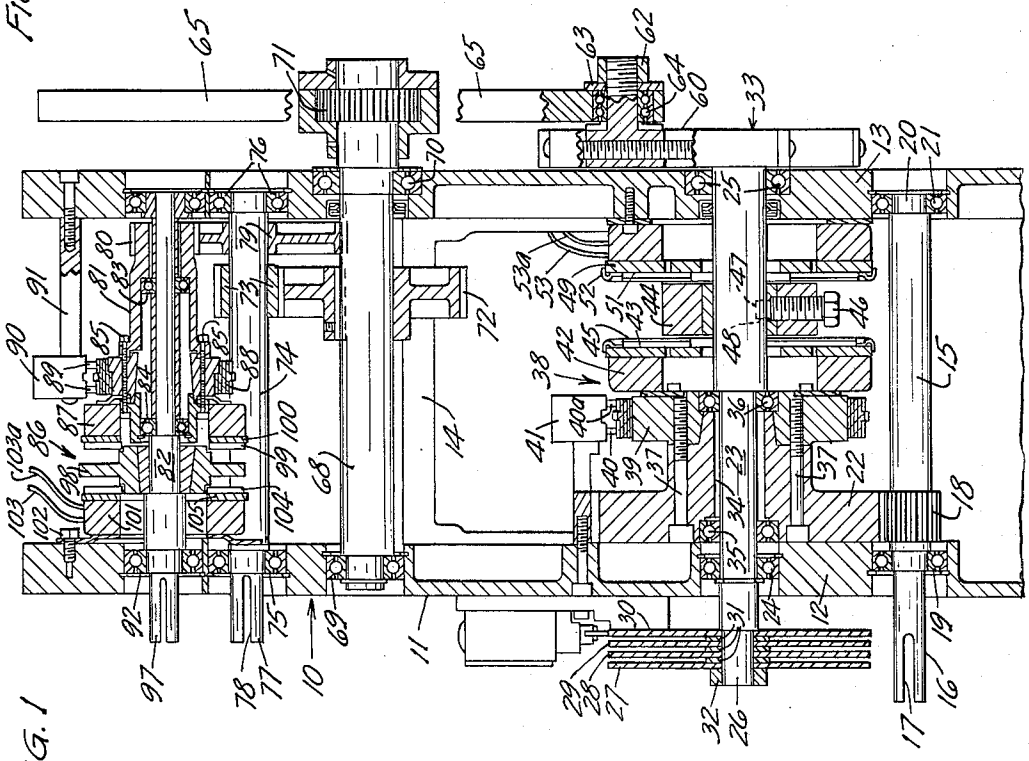


FIG. 1

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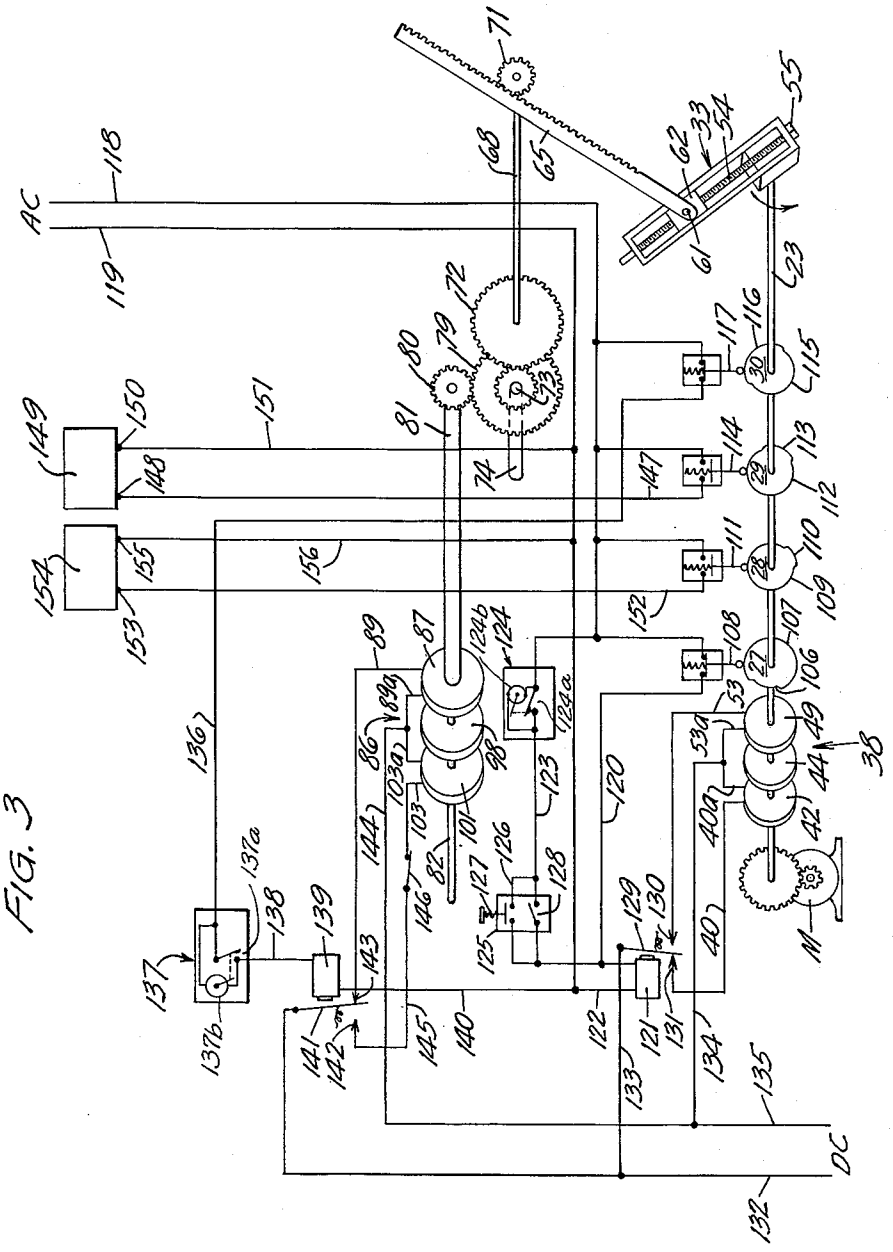


FIG. 3

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2,997,889

INTERMITTENT ENGINE

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19 Claims. (Cl. 74—125.5)

This invention relates to an intermittent engine, and more particularly to apparatus for transmitting sequential motion in cyclic operation with provision for varying and controlling movement and time intervals.

In many instances of automation, it becomes desirable to perform a sequence of operations at high speeds. Generally, some of the operations have fixed time relations with respect to other operations and the sequence is intended to be held irrespective of the speed of operation or rate of production. Other of the operations may require independent adjustment for either time or motion, and the total setting or adjustment of such a machine can become highly complex. This is particularly true where direct cam operation is employed with a continuously rotating cam shaft driven simultaneously with a power shaft. Changing one cam must necessarily augment or diminish the camming period of another at the same speed of rotation. Changing the speed to accommodate a particular operational period will then alter a previously described period for other operations.

In the case of electrically operated controls, cycles and periods of operation can be more easily adjusted, but difficulty is often encountered at high speed operation where mechanical parts must all rely upon independent actuation through independent control. Where mechanical parts are thus independently controlled, the controlling adjustment mechanism does not necessarily have a true relationship with time or motion since the momentum of mechanical parts thus independently controlled must be taken into consideration.

Furthermore, in transmission devices of the character requiring direct power to be taken intermittently from a constant speed shaft, full load is often applied instantaneously and the torque requirements cannot be met at the initial stage of the intermittent period. The torque requirements immediately thereafter may drop to but a fraction of the available power, which must remain at a high level to accommodate starting requirements.

It is, therefore, an important object of this invention to provide apparatus for the transmission of power to perform a sequence of operations in a periodic cycle wherein fine and accurate control can be established for all the operations.

Another object of the invention is to provide an intermittent engine for powering sequential operations wherein the time period of one operation can be varied completely independently of others to simplify control of machine operation. More particularly, the intermittent engine herein disclosed is adaptable to use with machinery for manufacture of items requiring duplicate operations except for certain variable such as the quantity of material apportioned to vary the size of the item. Thus, where articles are made from continuously fed sheet material, the amount of material fed can be varied without requiring readjustment of the timing of other operations in the same cycle.

A further object of the invention is to provide an easily and accurately controlled transmission apparatus wherein the degree of lost motion and momentum of moving parts can be usefully predetermined, a positive drive being employed upon the output shaft to enforce both acceleration and deceleration whereby any momentum override of parts driven by the output shaft can be virtually eliminated.

A still further object of the invention is to provide intermittent transmission of power wherein the dwell period between successive cycles of operation may be varied, yet high starting torque may be always provided at the beginning of power transmission.

Another object is to provide an intermittent engine with variable operating and non-operating periods wherein, within each cycle of operation, oscillating power as well as unidirectional intermittent power may be obtained from a steady power input.

Yet another object of the invention is to provide a transmission and control device of the character described wherein the adjustment of both motion and time in eachv cycle of operation is so accurately controlled that a certain cycle may be observed by an operator and adjustment made for a subsequent cycle, which, when accurately established on an individual cyclic basis, can then be utilized in continuous production without further adjustment.

These and other objects and advantages of the invention will more fully appear from the following description made in connection with the accompanying drawings wherein like reference characters refer to the same parts throughout the several views and in which:

FIGURE 1 is a vertical section of the intermittent engine taken on the line 1—1 of FIGURE 2, certain portion thereof being shown in full line representation and others being cut away to better show the working relationship of the parts:

FIGURE 2 is a side elevation of the intermittent engine taken from the right side of FIGURE 1; and

FIGURE 3 is a schematic representation of the functioning parts of the intermittent engine, together with an electrical wiring diagram illustrating the operation of such engine and the timing of industrial operation within each cycle.

With continued reference to the drawings, and particularly to FIGURES 1 and 2, the intermittent engine is indicated generally at **10**. The engine is provided with a supporting frame or structure **11** having side walls **12** and **13** as well as cross bracing structure **14**. Journaled across the side walls **12** and **13** is a jack shaft **15** with an outer extension **16** having a slotted connection **17** for rotation by a prime mover M, as shown in FIGURE 3. The jack shaft **15** has a pinion gear **18** mounted adjacent the bearing **19** which, in turn, is mounted in the wall **12**, as shown. The opposite end **20** of jack shaft **15** is journaled in the bearing **21** which, in turn, is mounted in the wall **13** in alignment with bearing **19**. The jack shaft **15** is drivably connected through the pinion gear **18** with gear **22** which, in turn, is mounted rotatably upon the power transmission shaft **23** which lies in spaced parallel relation to jack shaft **15** and is journaled respectively in bearings **24** in wall **12** and **25** in wall **13**. The power transmission shaft **23** is the input shaft which responds to the continuously rotating jack shaft **15** in the manner hereinafter described. The power transmission shaft **23** is provided with a reduced outer extension **26** to which are rigidly secured a plurality of cam wheels **27**, **28**, **29** and **30**, each of the cam wheels being separated by a washer member **31** and the assemblage held in its rigid relationship with the power transmission shaft **23** by means of a nut **32** threadedly secured to the outer reduced extension **26** of shaft **23**, as shown in FIGURE 1. The other end of power transmission shaft **23** is rigidly secured to a crank arm **33** which lies just beyond the wall **13** of supporting structure **11**, as shown in FIGURES 1 and 2.

The gear **22** has an internal bore **34** which surrounds the power transmission shaft **23** and rotates thereabout on roller bearings **35** and **36** respectively. Gear **22** is provided with stud bolts **37** passing therethrough to the right,

as shown in FIGURE 1, and cooperating in rotatable relation with an electric clutch-brake assembly indicated generally at 38. The clutch-brake assembly, in turn, comprises an electrical collector device 39 which picks up an electric current from the terminal brushes 40 and 40a which, in turn, are held in fixed relation to a brush holder 41 secured to the frame structure 11. The clutch-brake assembly also has secured to the gear 22 a magnetic clutch element 42, which in turn is provided with a clutch face 43, as shown in FIGURE 1. The magnetic clutch 42 has annular clearance concentrically with the input or power transmission shaft 23, as shown in FIGURE 1. Shaft 23 has secured thereto a core 44 which, in turn, supports a resilient, magnetically attractable clutch disc 45 normally in light slipping contact with clutch face 43. A stud bolt 46 is threadably mounted in the core 44 and is provided with a pin extension 47 adapted to interlock in a closely fitting recess 48 formed in the input or power transmission shaft 23, as shown. Thus, when the magnetically attractable disc 45 is urged into firm engagement with the clutch face 43, the shaft 23 is caused to rotate together with the gear 22 and its associated clutch parts.

Also included in the clutch-brake assembly 38 is a magnetic brake element 49 which is mounted rigidly to the wall 13 of supporting structure 11 by such means as stud bolts 50, as shown in FIGURE 1. The magnetic brake element 49 and its face 51 are in concentric clearance with the shaft 23. A resilient brake disc 52 secured to core 44 normally lies in light slipping contact with brake face 51. When the magnetic brake 49 is energized through electric leads 53 and 53a, the magnetic clutch 42 is deenergized, releasing clutch disc 45 but instantaneously causing brake disc 52 to become rigidly stopped in engagement with the brake face 51. Since the pin 47 is locked in recess 48 of input or power transmission shaft 23, the latter will be immediately stopped in its rotation. Since the cam wheels 27—30 are rigidly secured to shaft 23, and the crank 33 is likewise secured to shaft 23, the latter members will also stop instantaneously in their rotation whenever the brake disc 52 is caused to engage the brake face 51.

The crank 33 which is secured to one end of shaft 23 is provided with a longitudinal adjusting screw 54 having a knurled thumb nut 55 for rotation thereof, as shown in FIGURE 2. The outer end of adjusting screw 54 is rotatably journaled in an end plate 56 while the inner end thereof is rotatably mounted in the end plate 57 of crank 33, as shown. A collar 58 is secured to the outer end of adjusting screw 54 so as to prevent endwise play of the screw during operation of the machine or adjustment of the screw. The crank 33 has a guide slot 59 in parallel clearance with the adjusting screw 54 in which a block 60 is slidably disposed, as shown in FIGURE 1 and FIGURE 2. Block 60, in turn, is provided with an outwardly extending pivot pin 61, the outer end of which threadably retains a nut 62. A bearing collar 63 is rigidly secured to the pivot pin 61 by nut 62 and the collar, in turn, has roller bearing connections 64 with a rack 65 which in turn is provided with teeth 66 and is slidably mounted within the guide 67.

The guide 67 is oscillably secured to a jack shaft 68 which is journaled in bearings 69 and 70, respectively, mounted in the side walls 12 and 13 of supporting structure 11. The guide 67 is secured at an outward extension 70 of the jack shaft 68 and surrounds a pinion gear 71 which is rigedly secured to the jack shaft 68. The guide 67 maintains the rack 65 in intermeshed engagement with pinion 71 as the crank element 33 revolves about the axis of shaft 23, causing the jack shaft 68 to rotate first in one direction and then in the other. The number of revolutions of the jack shaft in each direction is, of course, dependent upon the radial setting of the block 60 in the crank element 33.

Secured to the jack shaft 68 is a gear 72 which, in turn, is meshed with a gear 73 secured to a power take-off shaft 74 journaled in bearings 75 and 76 respectively mounted in the sides 12 and 13 of the supporting structure 11. The power take-off shaft 74 has an extension 77 with slot 78 for interfitting with machine parts requiring periodic oscillatory movement. Also secured to the shaft 74 is a gear 79 which intermeshes with an other gear 80 which, in turn, is secured to a sleeve 81 is driven by crank 33 and hence operates as an oscillable mechanism and sleeve 81 is rotatably mounted on shaft 82 which constitutes the intermittent output of the engine. Free relative rotation between sleeve 81 and output shaft 82 is assured through the roller bearing assemblies 83 and 84. Sleeve 81 is provided with stud bolts 85 passing to the left, as shown in FIGURE 1. An electric clutch-brake assembly 86 provides a disengageable driving member and also surrounds the shaft 82 and comprises a magnetic clutch 87 with an electrical collector device 88 which picks up an electric current from the brush terminals 89 and 89a projecting from brush holder 90. The brush holder is held in fixed relation to frame structure 11 by means of bracket 91 bolted to frame side 13, as shown. Magnetic clutch 87 lies in clearance with the circumference of shaft 82.

Shaft 82 is journaled across the frame sides 11 and 12 in bearings 92 and 93, respectively. The other end of output shaft 82 terminates outwardly of plate 11 in a slotted connector 97 which is adapted to impart unidirectional intermittent motion.

Secured to shaft 82 adjacent magnetic clutch 87 is a core 98 which supports a resilient magnetically attractable clutch disc 99 normally in light slipping contact with clutch face 100 or the magnetic clutch 87. Adjacent core 98 and in clearance with output shaft 82 is a magnetic brake element 101 which, in turn, is rigidly mounted on plate 11 by means such as stud bolt 102. Magnetic brake element 101 is energized by leads 103 and 103a and will then attract resilient brake disc 104, secured to core 98, firmly against brake face 105 of the brake element 101. As in the case of the clutch-brake 38, the brake disc, as well as the clutch disc, normally lies in light frictional engagement with the respective brake and clutch faces and upon alternate energization thereof will brake the rotation of shaft 82 and then will engage shaft 82 with the clutch while simultaneously releasing the brake.

A typical use of the intermittent engine is in connection with making containers from a sheet or web of flexible material wherein the web advances a predetermined distance, is stopped, cut, sealed and the finished container removed prior to again advancing the web. Timing of sub-events within the cycle becomes important because the time required for cutting and sealing is entirely unrelated to the time for advancing the web. Thus, for example, when one container is made per cycle, a linear dimension of the container is controlled by what portion of the cycle is consumed in advancing the web. The effectiveness of cutting and sealing is determined by what portion of the cycle is consumed in subjecting the material to the elements involved. Where containers of the same area dimensions have varying thicknesses of material, the web travel portion of the cycle will remain the same, but the portion of the cycle wherein the thicker material is cut and sealed may require a longer duration.

A diagrammatic arrangement of the essential parts of the intermittent engine is shown in FIGURE 3, together with a wiring diagram for operation thereof. For purposes of illustration, it is presumed that a cycle in the operation of the machine includes one complete rotation of the input shaft 23 beginning with the crank arm 33 in upright position in alignment with the gear rack 65 with rotation of shaft 23 in the direction of the arrow, as shown in FIGURE 3. Thus, the position illustrated is just subsequent to the beginning of a cycle wherein the crank arm 33 has progressed a short distance from the beginning point. Each of the cam wheels 27—30 are

fixed to shaft 23 and, hence, rotate whenever the crank arm 33 rotates. Cam wheel 27 has a low circumferential portion 106 and a high portion 107, one of which is in constant engagement with the spring-pressed cam following switch 108 at the dead center or beginning position of the crank arm 33. The switch 108 will be just climbing to the higher peripheral portion 107 to close the cam switch 108. Cam wheel 28 similarly is provided with a low circumferential portion 109 and a high portion 110. Cam wheel 28 is adapted to actuate a spring-pressed cam following switch 111 so that the switch will be closed when the high portion 110 is in contact therewith. Similarly, the cam wheel 29 has a low portion 112, a high portion 113 and the cam wheel 29 is adapted to actuate the spring-pressed cam following switch 114. Cam wheel 30 has a low circumferential portion 115 and a high portion 116 adapted to sequentially operate the spring-pressed cam following switch 117. The cam wheels 27 and 30 are designed to operate the respective clutch brake systems 38 and 86. The cam wheels 28 and 29 are illustrative of any of a plurality of electrically operated mechanisms which are caused to operate or conditioned to operate in sequence with respect to the single revolution of the input shaft 23. As illustrated, the function of the cam wheels 28 and 29 is one of certain and fixed operation with respect to a revolution of the shaft 23, whereas the cam wheels 27 and 30 control variable aspects of the operation of the intermittent engine as will be described hereinafter.

The operation of our intermittent engine presupposes that the motor M is constantly energized to provide steady rotation to the clutch member 42. A source of solenoid operating current is supplied through the lines 118 and 119. Presuming that the cam switch 108 has not yet closed the circuit from line 118 to conductor 120, there is no energization of the electro-magnetic switch coil 121 through conductor 122 and back to the neutral line 119. It will be noted that a parallel circuit exists through the line 123 in which a switch mechanism 124 and a master switch assembly 125 are interposed. The switch mechanism 124 has a pair of electrical contacts 124*a* and a switch actuator such as timer 124*b* for opening the contacts after a predetermined time interval. The master switch assembly 125 has a short by-pass line 126 which is capable of being closed through manual depression of the spring-pressed thumb button switch 127. The manual switch 128 may be moved to either a constantly open or closed position for engaging or disengaging the automatic operation of the engine. With the switch 128 open, the thumb button 127 may be utilized for producing a single cycle particularly useful for test purposes. Just prior to operation of the machine with the crank arm 33 in the beginning position as previously noted, the cam wheel 30 will be about to close the cam switch 117.

To begin operation of the device, it is presumed that the switch mechanism 124 will be in the closed position shown. If it is desired to utilize but a single cycle, then the manual switch 128 is left in open position, as shown. The thumb button 127 is then depressed so as to momentarily close the circuit from line 118 and lead 123 to the coil of the electro-magnet 121. Switch 129 which was previiusly in contact with the contact 130 of lead 53 now swings to the left under the influence of coil 121 and establishes contact with the contact point 131. The D.C. current circuit through switch 129 from the line 132 now flows through the interconnecting conductor 133 and into the lead 40 to the clutch 42. The return line from the clutch 42 passes through conductor 40*a*, conductor 134 and back to the other line 135 of the D.C. current source. Energization of the electro-magnetic clutch 42 causes the constantly rotating motor M to engage with the core element 44 which, in turn, is secured to the input shaft 23. Shaft 23 then causes crank shaft 33 to which it is secured to rotate counterclockwise as viewed in FIGURE 3. Just prior to the energization of electro-magnetic coil

121, the switch 129 was in contact with the contact point 130 and is so constructed and biased as always to assume the latter contact whenever the electro-magnetic coil 121 is deenergized. The contact between switch 129 and contact point 130, of course, establishes a direct current flow through the line 132, conductor 133, switch 129, contact 130, lead 53 and into the magnetic brake element 49. The current then flows through the conductor 53*a*, the return lead 134 and back to the direct current line 135. Electro-magnetic clutch 42 is disengaged under those circumstances and the core 44 is magnetically attracted in braking relation with the electro-magnetic brake element 49 which maintains the input shaft 23 in rigidly held non-rotating position. The motor M, of course, continues to operate whether or not the input shaft 23 is coupled thereto or not.

Upon the beginning of rotation of the crank arm 33, the upper circumferential portion of cam wheel 27 causes cam switch 108 to close and thereby to establish an independent circuit from the line 118 through switch 108, conductor 120, through electro-magnet 121, return lead 122 and finally to the other source line 119. Switch 129 thus maintains the electro-magnetic clutch 42 in engagement with core 44 so that input shaft 23 will continue to operate as long as the cam switch 108 rides on the high portion 107 of cam wheel 27.

It will be remembered that, since all the cam wheels 27—30 are rigidly secured to the input shaft 33, cam wheel 30 also began to turn in a counterclockwise direction when the engagement of motor M was established through the electro-magnetic clutch 42. As soon as the crank arm 33 moved from its dead-center relation in alignment with rack 65, the cam switch 117 was closed by virtue of riding up on the upper peripheral portion 116 of cam wheel 30. The closing of the cam switch 117 immediately establishes a circuit from line 118 through switch 117, along the conductor 136 and into switch mechanism 137, the contacts 137*a* of which are normally closed at the beginning of the cycle, but may be interrupted by switch actuator 137*b* either after the passage of a predetermined length of time or the completion of a sequenced operation as will hereinafter be described. Electrical current passing through the switch mechanism 137 then passes through conductor 138, through electro-magnetic coil 139, through return lead 140 and back to the neutral line 119. Switch 141 which normally lies in biased contact with the contact point 142 when coil 139 is deenergized, is now swung over to establish contact with the point 143, as shown in FIGURE 3. The electro-magnetic clutch 87 is thus energized through the direct current line 132, through switch 141, contact 143, and into the electro-magnetic clutch element 87. The return lead is through conductor 89*a* and conductor 144, then back to the other direct current line 135. Just prior to energization of the coil 139, the electro-magnetic brake 101 was energized through the circuit leading from line 132, through switch 141, contact point 142, lead 145, manual switch 146, conductor 103 and to the electro-magnetic brake element 101. The return line is through conductor 103*a*, conductor 144 and back to the other direct current line 135. As long as the coil 139 remains energized, switch 141 and contact 143 will be closed. The electro-magnetic clutch element 87 will then engage the core 98 and maintain the sleeve 81 in driving engagement with the output shaft 82. Conversely, when the electro-magnet 139 is deenergized, the switch 141 will assume its normal contact with the contact point 142 and immediately establish electroc-magnetic brake 101 in braking relation with core 98 to hold the output shaft 82 against rotation. Sleeve 81 and clutch 87 will then be free to rotate without imparting any rotation to the output shaft 82.

Sleeve 81 is in constant engagement with the shaft 68 because of the intermediate gear train including the gears 72, 73, 79 and 80. The pinion gear 71, of course, lies in

contact with rack 65. As the crank arm 33 continues in its counterclockwise travel, the rack 65 will pull downward on the pinion 71 and cause counterclockwise rotation of the output shaft 82. Since the cam switch 117 remains in closed condition as long as the high portion 116 of cam wheel 30 is in contact therewith, the electromagnetic clutch 87 will maintain its driving contact between sleeve 81 and output shaft 82 unless switch 137 is opened sooner.

As the input shaft 23 continues rotating the crank arm 33, the cam switch 108 also remains closed because it is in contact with the high portion 107 of the circumference of cam wheel 27. Other cam wheels such as 28 and 29 may be utilized to perform various functions electrically during the cycle. Thus, in the continued rotation of the crank arm 33, cam switch 114 will be closed by actuation thereon from the high portion 113 of cam wheel 29. When this occurs, the conductor 147 will establish connection between line 118 and terminal 148 of electrical actuator 149. The return lead from terminal 150 includes the conductor 151 which again connects to line 119. The electrical actuator 149 may be utilized for any intermediate function to be performed during the cycle and independently of the timed relationship with the intermittent motion hereinafter described. In a similar manner, when the raised circumferential portion 110 of cam wheel 28 engages the cam switch 111, a circuit is established through the conductor 152 which connects with the terminal 153 of electrical actuator 154, the other terminal 155 of which connects with the return conductor 156 and back to the neutral line 119. It is understood that the actuators 149 and 154 may be in the nature of switches, solenoids, relays and so forth, which may, in themselves, perform a function or which may initiate another function to be performed during the aforementioned cycle.

As the crank arm 33 continues in its counterclockwise downward movement carrying the rack 65 therewith, it finally reaches its lowermost position at which time the cam switch 117 will open by virtue of dropping back to the lower circumferential portion 115 of the cam wheel 30. This occurs at substantially the lowermost portion of the stroke wherein the rack 65 is again aligned with the crank arm 33. The electro-magnetic coil 139 is then deenergized (if not previously deenergized by opening of switch 137*a* by actuation of mechanism 137*b*) and the clutch brake mechanism 86 is again reversed, as previously described, so as to deenergize the clutch 87 and establish braking relation with the electro-magnetic brake element 101. Output shaft 82 then (or at opening of switch 137) stops its rotation and is rigidly held in stopped position while sleeve 81 may be free to continue oscillatory rotation. Since the high portion 107 of the cam surface of cam wheel 27 is still in contact with cam switch 108, electro-magnetic coil 121 will remain energized and the motor M will remain in driving connection with the input shaft 23. On the upstroke of the crank arm 33, the lower circumferential portion 106 will eventually permit the cam switch 108 to be opened which, in turn, will deenergize the electro-magnetic coil 121 and reverse the relationship of the clutch brake 38 to energize brake 49 and deenergize the clutch 42. Input shaft 23 will then be rigidly held against rotation. All of the essential events will have taken place within the cycle although the crank arm 33 will not have completely returned to its starting position. The foregoing cycle is predicated upon a single actuation of the switch button 127 which, of course, can be repeated as often as desired. Each time the thumb button 127 is depressed, the electro-magnet 121 will be energized and will, of course, not be operably connected through line 120 until the upper circumferential portion 107 of cam wheel 27 again closes the cam switch 108. This, of course, occurs at the beginning point of the cycle as previously described. Now, where the manual switch 128 is established, the clutch 42 will be kept energized irrespective of the cam 27. The cycle will thus be automatically repeated until such time as manual switch 128 is again opened. It is to be noted that where the cam 30 has a high portion 116 which approaches 180° and this high portion 116 controls the full period for which the clutch portion 87 of the clutch brake mechanism 86 is energized, output shaft 82 will revolve throughout substantially the entire down stroke of the crank arm 33, so that only a small portion of the stroke need be abruptly disconnected from driving relation with shaft 82. The character of the rotation of output shaft 82 is virtually sinusoidal, beginning from rest to a maximum speed when the crank arm 33 has advanced approximately ninety degrees. Shaft 82 then slows down until it again comes to rest with the crank arm 33 in lower position aligned once more with rack 65. This is an important feature of our invention since the intermittent motion of the output shaft 82 may be utilized in many ways for machine movements requiring high accelerating torque as well as high decelerating torque. The required horsepower of motor M as well as the strength of materials such as the gear train and the shaft sizes, can be greatly decreased as contrasted to a situation where moving parts of a machine are intermittently connected directly to full speed moving parts. The accuracy of timing our intermittent engine is greater where high portion 116 of cam 30 approximates a full stroke of rack 65 because of smoother operation of the parts. Momentum, effects, both in starting and stopping, are minimized where the normal rotation of output shaft 82 is cut off close to the end of travel of rack 65 and thus do not complicate the problem of arriving at optimum conditions for adjusting both time and motion of the moving parts.

Since the cam 30 rotates once with shaft 23 for each operating cycle, the high portion 116 may be selected of such length and such position as to obtain other useful effects. For example, clutch 87 can be caused to engage output shaft 82 near the beginning of a stroke of rack 65 to conserve power and minimize momentum effects for starting machine motion but may stop considerably before the end of the same stroke where momentum effects are to be deliberately inserted and controlled. Thus a conveyor element for handling particles of material can move them under driving power of shaft 82 at the beginning of a stroke without relative movement, and then can cause the particles to tumble and separate by sudden termination of the conveyor travel during the decelerating portion of the stroke. By way of further example, clutch 87 may be caused to stop close to the end of the above mentioned stroke so that parts driven by the output shaft will be decelerated under power and the clutch 87 caused to disengage and brake 101 to engage for the purpose of precise stopping parts such as rollers for advancing webs and the like with minimum strain upon the brake and with minimum residual momentum in the rollers or other mechanism employed for advancing the web. Such web advancing mechanism is well known in the art and, hence, is not thought necessary to be described in greater detail.

Our invention further contemplates independent adjustments of certain portions of the timing cycle which do not necessarily affect the overall timing of the complete cycle. Thus, timing switch mechanism 137 may independently interrupt and reestablish the circuit through line 136 to the electro-magnet coil 139 at any time during which cam switch 117 remains closed. When this occurs, the switch 141 will snap over to energize the brake 101 while releasing clutch 87 and rotation of output shaft 82 can be limited to any shorter time after the start of the cycle to a point prior to 180 degrees in the rotation of crank arm 33. Thus, for the same period of the total cycle, the output shaft 82 may be caused to rotate at a slower or faster speed, depending on whether the pivot block 62 has been moved inwardly toward the center of input shaft 23 or has been moved outwardly therefrom via the adjustment screw 54.

By way of illustration of the usefulness of the electrical control combination of switch **137** and cam switch **117**, block **62** on crank arm **33** may be set to yield a given number of revolutions of output shaft **82** utilizing the maximum high portion **116** of cam **30** and cutting short only a minimum amount of the normal rotation of the output shaft to feed a length of roll material for fabricating the walls of a continer, for example. Switch **137** can then be caused upon the next stroke of rack **65** to further cut short the normal rotation of output shaft **82** and, therefore, feed a shorter length of roll material for a second container element and so on for a third and more times to obtain a series of cycles using different numbers of revolutions of the output shaft but each time employing high starting torque and a single set adjustment for the radius of crank **33**. Contacts **137***a* of switch **137** may be operated by a number of means **137***b* such as, for example, automatic timed mechanism or may be responsive to premarked indicia on the roll material itself to determine the point at which the normal rotation of output shaft **82** will be further curtailed over that imposed by cam **30**.

The foregoing description has related to adjusting the times of certain events within a predescribed cycle of time. Occasionally it is desirable to maintain the same speed of operation and the same timed relation between certain of the events occurring during the cycle and then to independently increase the total time period in the cycle by adding a rest period of predetermined length at the end of one cycle and prior to the beginning of the next. Thus it will be observed that the low portion **106** in the circumference of cam wheel **27** permits the cam switch **108** to open prior to the completion of one complete revolution of the crank arm **33**. As was previously pointed out, if the switch mechanism **124** remains closed and the manual switch **128** is closed, a parallel circuit is established through line **123** to maintain the electro-magnetic coil **121** energized and the interruption of cam switch **108** has no effect upon the continued rotation of input shaft **23**. Now, however, where it is desired to insert a rest period at the end of one cycle and prior to the beginning of the next, the switch mechanism **124** may be closed at the beginning of the cycle and then may be opened at some period while the cam switch **108** is riding on the raised portion **107** of cam wheel **27** in closed condition. Now the continued driving connection between motor M and the input shaft **23** is dependent upon the energization of clutch **42** in the clutch brake mechanism **38**, established through the conductor **120**. When the cam switch **108** drops to the lower level **106** with switch mechanism **124** in open position, then the clutch **42** will be disengaged and brake **49** will be engaged so that no further rotation is imparted by motor M to the input shaft **23**. The switch mechanism **124** may then be responsive to some other timed interval so that when contacts **124***a* are again closed by timing mechanism **124***b*, the coil **121** will be energized and input shaft **23** will again rotate through its connection with clutch brake mechanism **38** and the continuously rotating motor M. Switch mechanism **124** thus becomes a means of inserting controlled rest periods within a series of cycles which will not affect the speed and character of the other events within the cycle once they are set in motion. Maximum cyclic operation of the engine may be obtained by minimizing the duration of the rest periods to only that amount which is necessary.

In addition to the foregoing features, it is sometimes useful to supply oscillating movement within a cycle of operation and, to this end, we may employ the power take-off shaft **74** which rotates first in one direction and then in the other as the gear rack **65** oscillates in response to the rotation of crank arm **33**.

Our intermittent engine is so constructed that a complete cycle may be accomplished with the main switch **28** in open position merely by momentarily depressing the button **127**. All adjustments made by virtue of observing single cycles are of such nature as to hold, unchanged, for the automatic and continuous operation where the cycles are successively repeated. Furthermore, once proper adjustment is made for a given set of circumstances, the entire production of machine output can be speeded up or slowed down by studying the speed of motor M and the new value. It is understood, of course, that the selection of a speed for motor M will not be arbitrarily varied during the individual cycles. However, speed of motor M may be varied at will without affecting an operation taking place during a controlled rest period inserted by switch **124**.

It will, of course, be understood that various changes may be made in the form, details, arrangement and proportions of the parts without departing from the scope of our invention.

What we claim is:

1. In an intermittent engine adapted to power a cyclic sequence of timed operations, an input shaft powered for rotation in one direction during each cycle of operation, an output shaft adapted normally to rotate for a portion of each cycle, means drivably interconnecting the input and output shafts, means responsive to rotation of the said input shaft for establishing the normal rotation of said output shaft, and means independent of said means responsive to rotation of said input shaft adapted to interrupt during the normal rotation of said output shaft the means drivably interconnecting the input and output shafts and to cut short the rotation of the latter, whereby to predetermine the duration of the cyclic period of rotation of said ouput shaft.

2. In an intermittent engine adapted to power a cyclic sequence of timed operations, an input shaft powered for rotation in one direction during each cycle of operation, an output shaft adapted normally to rotate for a portion of each cycle, an oscillable mechanism operated by the input shaft, a driving member between the oscillable mechanism and the output shaft, responsive to rotation of the said input shaft for establishing the normal rotation of said output shaft, and means independent of said means responsive to rotation of said input shaft adapted to interrupt during the normal rotation of said output shaft the connection between the driving member and the output shaft and to cut short the rotation of the latter whereby to predetermine the duration of the cyclic period of rotation of said output shaft.

3. In an intermittent engine adapted to power a cyclic sequence of timed operations, an input shaft powered for rotation in one direction during each cycle of operation, an output shaft adapted normally to rotate for a portion of each cycle, a crank secured to and rotated by the input shaft, a gear rack pivotally mounted to the crank, a gear driven by the rack and operably connected to the output shaft, means responsive to rotation of said input shaft for establishing the normal rotation of said output shaft, and means independent of said means responsive to rotation of said input shaft adapted to interrupt during the normal rotation of said output shaft the operable connection between said gear and said output shaft and to cut short the rotation of the latter, whereby to predetermine the duration of the cyclic period of rotation of said output shaft.

4. In an intermittent engine adapted to power a cyclic sequence of timed operations, an input shaft powered for rotation in one direction during each cycle of operation, an output shaft adapted normally to rotate for a portion of each cycle, means drivably interconnecting the input and output shafts, a cam mounted on the input shaft for rotation therewith for establishing the normal rotation of said output shaft, and means independent of said cam and adapted to interrupt during the normal rotation of said output shaft the means drivably interconnecting the input and output shafts for the portion of each cycle which defines the period during which the output shaft does not rotate.

5. In an intermittent engine adapted to power a cyclic

sequence of timed operations, an input shaft powered for rotation in one direction during each cycle of operation, an output shaft adapted to rotate in one direction for a portion of each cycle, an electric output clutch-brake mechanism having a clutch portion and a brake portion mounted in engageable driving connection with the output shaft and adapted to be energized alternately to establish rotation of said output shaft through the clutch portion and then for rigidly holding against rotation through the brake portion, means drivably interconnecting the input shaft with the clutch portion of the output clutch-brake mechanism, electrical switch means responsive to rotation of said input shaft adapted to predetermine the normal duration of energization of said output clutch portion within each cycle of operation, and independently actuated means adapted to interrupt during the normal rotation of said output shaft the energization of said clutch portion and to establish energization of said brake portion whereby to shorten the period of energization of said clutch portion and stop rotation of said output shaft.

6. In an intermittent engine adapted to power a cyclic sequence of timed operations, an input shaft powered for rotation in one direction during each cycle of operation, an output shaft adapted to rotate in one direction for a portion of each cycle, an electric output clutch-brake mechanism having a clutch portion and a brake portion mounted in engageable driving connection with the output shaft and adapted to be energized alternately to establish rotation of the shaft through the clutch portion and then for rigidly holding against rotation through the brake portion, means drivably interconnecting the input shaft with the clutch portion of the output clutch-brake mechanism, electrical switch means responsive to rotation of said input shaft adapted to predetermine the duration of energization of said output clutch portion within each cycle of operation, and means interrupting rotation of said input shaft for a predetermined time interval at the end of one cycle and before the beginning of the next.

7. The subject matter set forth in claim 1, and additional means responsive to rotation of said input shaft for establishing a timed operation of predetermined duration and beginning at a fixed time after the beginning of each cycle of operation of said input shaft and unaffected by change in the predetermined period of duration of rotation of said output shaft.

8. In an intermittent engine adapted to power a cyclic sequence of timed operations, an input shaft powered for rotation in one direction during each cycle of operation, an output shaft adapted to rotate for a portion of each cycle, a first electric clutch-brake mechanism having a clutch portion and a brake portion mounted in engageable driving connection with the output shaft and adapted to be energized alternately to establish rotation of the shaft through the clutch portion and then for rigidly holding against rotation through the brake portion, means drivably interconnecting the input shaft with the clutch portion of the clutch-brake mechanism, electrical switch means in constantly driven relation with said input shaft adapted to predetermine the duration of energization of said output clutch portion within each cycle of operation, a second electric clutch-brake mechanism having a clutch portion and a brake portion mounted in engageable driving connection with the input shaft and adapted to be energized alternately to establish rotation of the input shaft through the clutch portion and then for rigidly holding against rotation through the brake portion, electrical switch means in constantly driven relation with said input shaft adapted to predetermine the duration of energization of said input clutch portion for the entire cycle of operation, and switch means adapted to initiate a new cycle of operation after passage of a predetermined amount of time.

9. In an intermittent engine adapted to power a cyclic sequence of timed operations, a continuously rotating motor drive, an input shaft, a first electric clutch-brake mechanism having a clutch portion and a brake portion mounted in engageable driving connection between the motor drive and the input shaft and adapted to be energized alternately to establish a rotational cycle of the input shaft through the clutch portion and then for rigidly holding against rotation through the brake portion, an output shaft adapted to rotate for a portion of each cycle, a second electric clutch-brake mechanism having a clutch portion and a brake portion mounted in engageable driving connection with the output shaft and adapted to be energized alternately to establish rotation of the shaft through the clutch portion and then for rigidly holding against rotation through the brake portion, means drivably interconnecting the input shaft with the clutch portion of the output clutch-brake mechanism, electrical cam switch means in constantly driven relation with said input shaft adapted to predetermine the maximum duration of energization of said output clutch portion within each cycle of operation, additional switch means in series with said electrical cam switch for independently interrupting energization of said output clutch portion prior to said maximum duration of energization, a second electrical cam switch in constantly driven relation with said input shaft adapted to determine the minimum time for completing one cycle of operation, and a second electric switch in parallel circuit with said second cam switch for inserting a predetermined time interval after completion of the minimum time cycle.

10. An intermittent engine for a cyclic sequence of timed operations comprising an input shaft powered for rotation in one direction during each cycle of operation, an output shaft rotatable for a portion of each cycle, first accelerating then decelerating in the same direction of rotation, means drivably interconnecting the input and output shafts and applying force on said output shaft during acceleration and reversely applying force during deceleration, means responsive to the rotation of said input shaft for establishing rotation of said output shaft for said portion of each cycle, and independently actuated means adapted to abruptly interrupt the full normal rotation of the output shaft substantially at the end of the forcible deceleration thereof whereby to substantially absorb momentum effects and minimize strain on the last mentioned means when abruptly interrupting rotation of the output shaft.

11. In an intermittent engine adapted to power a cyclic sequence of timed operations, an input shaft powered for rotation in one direction during each cycle of operation, an output shaft adapted to rotate in one direction for a portion of each cycle, an oscillable mechanism operated by the input shaft, said oscillable mechanism having for each oscillation high torque starting and finishing characteristics, a driving member between the oscillable mechanism and the output shaft, means responsive to the rotation of said input shaft adapted to rigidly engage the driving member normally with the output shaft near the beginning of each oscillation and to disengage the driving member from the output shaft near the end of each oscillation, and means independent of said means responsive to the rotation of said input shaft adapted to operate during rotation of the output shaft to shorten the normal period of rotation thereof from its high torque beginning to its high torque ending.

12. The subject matter set forth in claim 11 wherein said driving member is electrically operated and said means adapted to operate during rotation of the output shaft includes an electric switch mechanism.

13. The subject matter set forth in claim 12 wherein the means responsive to the rotation of said input shaft includes a cam following switch.

14. The subject matter set forth in claim 13, and an electric circuit including in series said cam following switch and said switch mechanism, the latter being adapted to open while the former is still closed.

15. In an intermittent engine adapted to power a

cyclic sequence of timed operations, an input shaft powered for rotation in one direction during each cycle of operation, an output shaft adapted normally to rotate for a portion of each cycle, means drivably interconnecting the input and output shafts, means responsive to rotation of said input shaft and adapted to interrupt the means drivably interconnecting the input and output shafts for establishing the normal rotation of said output shaft, and means adapted to interrupt for a predetermined period of time the rotation of said input shaft at the end of said cycle to increase the total time thereof without affecting the period of operation of said output shaft.

16. The subject matter set forth in claim 5 wherein the means drivably interconnecting the input shaft with the output clutch portion has a positive rack and gear assemblage for oscillating the same.

17. The subject matter set forth in claim 6 wherein the means drivably interconnecting the input shaft with the output clutch portion has a positive rack and gear assemblage for oscillating the same.

18. The subject matter set forth in claim 10 wherein said means drivably interconnecting the input and output shafts comprises an oscillable rack in driving relation with a gear assembly.

19. The subject matter set forth in claim 18 wherein said rack is driven by an eccentrically adjustable crank.

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