This invention relates to a novel method of operating pumping equipment, particularly of the deep well reciprocating type and to improved methods and means for effectively driving a deep well pump.

In a deep well, reciprocating type pump of the character often used in deep well oil wells, a large amount of energy must be supplied to the pumping system to raise the moving parts of the well (pump rod and piston) together with the oil or other fluid, a relatively small amount of energy is required on the downstroke. The load on the driving motor varies over a wide range and is influenced by a large number of factors, including gravity of oil being pumped, the presence and amount of gas in the oil, the presence and amount of sand in the oil, the temperature and viscosity of the oil, the degree of wear in the working elements, whether the hole is straight or crooked, etc. It has been recognized repeatedly, in the past, that any prime mover and actuating apparatus which is subject to great changes in load and energy output is incapable of operating efficiently. For this reason, reciprocating deep well pumps have been provided with weights which attempt to counterbalance the weight of the sucker rods and pump piston, but these expedients are not satisfactory and extremely heavy, massive counterweights must be used in an attempt to counterbalance the reciprocating parts and the weight of the column of oil being lifted. These counterweights effectively double the total weight of the mass being moved and increase the inertia effect, requiring the use of more powerful prime movers; the inertia forces are often sufficiently great to cause breakage of pump rods upon reversal of the pump at the end of a stroke. Attempts have also been made to employ pneumatically counterbalances (as in Patents 1,624,577, 1,775,733 and 2,072,595) but these schemes have been found to be ineffective.

Furthermore, the usual walking beam arrangement used at a deep well pump introduces a bothersome problem in translating an oscillatory motion of the beam and accompanying movement of the beam end into a rectilinear motion of the sucker rod and pump piston. In an attempt to overcome this difficulty, hydraulic lifting units have been tried (see Patents 2,247,238, 2,292,331, 2,313,406 and 2,366,777 for example) but their complexity, cost, and relative fragility precluded their extensive use. Mechanical drives, such as the Scotch yoke of Patent No. 1,465,671 or the more intricate internal gear rack and pinion arrangement of Patent No. 2,200,292, have been found unsatisfactory because they are mechanically not efficient and subject to wear, breakage, etc. in field operation.

The present invention, in one of its aspects, relates to a method of operating a vertically reciprocable pump whereby, kinetic energy is utilized to best advantage. The preferred method of operation stores kinetic energy in an accumulator and imparts such energy directly to the pump stem to initiate an upstroke. The method, however, employs a rotating energy accumulator in which energy is stored and released in timed relation to the pump stroke and the energy requirements of the system, the prime mover contributing only when energy level in the accumulator drops below a predetermined minimum.

Another aspect of the invention is concerned with effective means for reciprocating a sucker rod and pump stem without the use of walking beams or complicated hydraulic systems; with an arrangement whereby rotary motion may be effectively translated into reciprocation of a pump stem; with driving means including a constantly rotating prime mover, a transmission connecting the prime mover with a ball bearing screw jack in operational engagement with a pump stem and means, controlled by rectilinear movement of the pump stem, for engaging and disengaging the transmission, this system (in connection with suitable energy accumulators) permitting pumping operations to be carried out with a minimum of inequality in load upon the prime mover and with a maximum utilization of kinetic energy available in the reciprocating mass of pump rods, etc.

One of the objects of the present invention, therefore, is to disclose and provide a novel method of operating a reciprocating pump having a pump stem, whereby a prime mover is disengaged from the pump stem during a part of the downstroke and energy is stored in an accumulator and then directly applied to the pump stem to initiate the upstroke thereof.

Another object of the invention is to describe a method of operation whereby energy is stored within and released from a flywheel, such flywheel being connected to and disconnected from a prime mover in a predetermined manner controlled by the pump stroke and the energy level in the flywheel.

Another object is to disclose and provide simple and effective means for imparting rectilinear, reciprocating motion to a pump assembly by the use of a ball bearing screw jack.

A further object is to disclose and provide a novel means for controlling pumping operations, absorbing energy in accumulators during portions of a downstroke, and releasing and applying such energy to the pump stem and driving means in timed relation to the stroke of the pump and energy output of the prime mover.

A related object of this invention is to provide a long stroke type of pumping mechanism that is capable of effectively storing kinetic energy developed by the action of gravity upon the combined mass of the vertically reciprocating pump elements during the downstroke and utilizing the stored kinetic energy to augment the energy developed by the prime mover during the upstroke.

Another object of my invention is to provide a long stroke type of pumping mechanism that does not utilize counterbalances to compensate for the weight of the reciprocating parts that operates with high mechanical efficiency.

A further object of my invention is to provide a long stroke type of pumping mechanism that operates with high mechanical efficiency, thereby substantially reducing frictional wear, and requiring less upkeep and repair, as well as less power to operate.

Other objects and advantages of my invention will become apparent from the following detailed description and accompanying illustrative drawings in which:

Fig. 1 is a side elevation of an exemplary form of the pumping apparatus according to this invention, installed in a well.

Fig. 2 is a top plan view of the pumping apparatus of Fig. 1 showing one embodiment of a transmission mechanism for coupling the prime mover and flywheel to the lifting mechanism.

Fig. 3 is a schematic wiring diagram indicating the relative position of the various limit switches that con-
trol the engagement and disengagement of the forward and reverse driving clutches and showing the relationship of the switches to the activating element of the longitudinally moving member.

Fig. 4 is an alternative embodiment of a pumping mechanism utilizing the ball bearing screw jack combination.

Fig. 5 is a cross sectional view taken on the lines V—V' of Fig. 4 showing one manner in which the rotation of the revolving screws is synchronized.

Fig. 6 is a cross sectional view taken on the line VI—VI of Fig. 1 showing one construction for preventing the longitudinally moving screw from rotating.

In the illustrative form of apparatus of Figs. 1, 2, and 3 the driving mechanism is shown positioned above a well provided with the casing 10 having a usual casing head 11 at its upper end. Within the casing and extending downwardly into the well is a tubing or production string 12 suitably suspended by a conventional tubing hanger 13. A production outlet is indicated at 14. Extending downwardly through the tubing is a string of sucker rods or pump rods 15 going down to a pump of any suitable and customary construction located at the desired level within the well. The upper end of the string of sucker rods may terminate in a polish rod which is screwed to a pump screw shaft 16 extending upwardly through the casing head 11.

In order to adequately protect the lower portion of the pump screw shaft from contamination with oil being pumped, the lower portion of such shaft may be enclosed within a tubular housing 18, the bottom of such housing being provided with suitable glands 19 through which extends a polish rod attached to the upper end of the series of sucker rods. The upper end of the housing or protective tubing 18 may be connected to the bottom of the housing 20.

Means are provided for imparting a rectilinear reciprocating motion to the pump screw shaft. Such means may comprise a nut sleeve 17 which surrounds the pump screw shaft 16. Means are provided for rotating the nut sleeve while restraining it from longitudinal motion. Such means may comprise a housing 20 mounted upon the casing head 11 covered by a plate 21 forming a part of an auxiliary accumulator cage 22. The nut sleeve 17 is mounted for rotation by means of antifriction bearings 23 and 24 suitably held in recesses formed in the bottom of housing 20 and in base plate 21 of the auxiliary accumulator cage 22. The bearings cooperate with the nut sleeve so as to permit rotation of the nut sleeve while restraining such sleeve against longitudinal motion.

The pump screw shaft 16 and the nut sleeve 17 constitute a ball bearing screw jack. The pump screw shaft is provided with a helical groove, the interior of the nut sleeve being provided with a complementary groove, force being transmitted from the nut sleeve to the screw shaft and vice versa by balls that interengage the complementary grooves of the two members. Ball bearing screw jack are well-known and one form is shown in Patent No. 2,343,507. Single, double or triple grooves may be formed in the nut and screw, each complementary set of grooves having its own ball circulating conduit formed in the nut sleeve. One of such ball circulating conduits is indicated by 17'.

The upper end of the pump screw shaft 16 extends through the auxiliary accumulator cage 22 and into a guide tube 30 mounted above the accumulator cage. In order to permit reciprocating motion of the pump screw shaft while restraining it from rotation, a wall or walls of the guide tube 30 may be provided with a longitudinally extending groove or grooves and the upper end of the pump screw shaft 16 may carry a guide wheel 31 (or key) in sliding or rolling engagement with such groove or grooves.

Means are provided for absorbing kinetic energy from the pump screw shaft or pump stem when such pump stem descends under the force of gravity. Such means comprise a directly responsive accumulator which, in the form illustrated in the drawings includes a series of springs 35, 36, and the like, positioned in the accumulator cage 22. Resting upon such springs is a pressure plate 37 provided with an upstanding central neck 38 extending into the lower portion of the guide tube 30 while neck 38 fits loosely around the pump screw 16. The upper end of such pump shaft 16 is provided with a head 39 adapted to contact the top of the neck 38 during the last portion of the downstroke.

Although various methods and arrangements may be utilized for driving the pump, the arrangement illustrated in the drawings has been found very effective. The lower end of the nut sleeve for example may be provided with a bevel gear 40, the housing 20 including a side port in which there is journaled (in suitable bearings) a driving shaft 41 provided with a bevel gear 42 in operative engagement with bevel gear 40 and an external flexible coupling 43 adapted to be connected to a driving means.

The power transmission system, shown in Figs. 1 and 2 by way of example, comprises a speed governed, prime mover 51 of any suitable type such as an electric motor or an internal combustion engine (gasoline, diesel or gas turbine engine). Prime mover 51 is connected by means such as a flywheel 52 through an overrunning clutch 53 secured to flywheel 52 and coupled to the prime mover by shaft 54. This type of clutch permits the flywheel to revolve faster than the prime mover at any time when the angular velocity of the flywheel exceeds the corresponding angular velocity of the prime mover. The details of construction of an overrunning clutch do not constitute a part of this invention and are well known to those skilled in the art.

Flywheel 52, preferably dynamically balanced, is mounted on a shaft 55 that is journaled in suitable bearings supported by bearing pillow blocks 56 and 57. A positive transmission means, for example a chain sprocket 58, is secured to shaft 55 and is preferably positioned between pillow blocks 56 and 57. Shaft 55 is also referred to herein as the first shaft.

A first, or forward driving, automatically operable clutch means 59 is attached, on one side, to a shaft 60 that is journaled in a bearing supported by bearing pillow block 61. This shaft is parallel to shaft 55. A chain sprocket 62 is secured to shaft 60 between clutch 59 and bearing pillow block 61 and is positioned in alignment with sprocket 58 secured to shaft 55. A chain 63 connects sprocket 58 directly to sprocket 62. Shaft 60 is also referred to herein as a countershaft.

The other side of clutch 59 is attached to a shaft 63' journaled in a bearing supported by bearing pillow block 64. Shaft 63' extends beyond pillow block 64 and a chain sprocket 65 is secured to that portion of the shaft that overhangs pillow block 64.

A shaft 66 is attached to the other side of flexible coupling 43 from that to which shaft 41 is attached, and is journaled in a bearing supported by a bearing pillow block 67. This shaft is parallel to shafts 55 and 60. Shaft 66 is provided with a chain sprocket 68 secured to it and positioned in alignment with sprocket 65. Preferably sprocket 68 is secured to shaft 66 between flexible coupling 43 and bearing pillow block 67. A chain 69 directly connects sprocket 66 and sprocket 65. Shaft 66 extends beyond bearing pillow block 64 and an energy stor is attached to one side of a second, or reverse driving, automatically operable clutch means 70. Shaft 66 in combination with shaft 41 is also referred to in this application as the nut shaft.

The opposite side of reverse driving clutch 70 is connected to a shaft 71 journaled in a bearing support by pillow block 72. A chain sprocket 73 is secured to shaft 71 and is positioned to align with and engage chain 63 on the outer side of the chain whereas sprockets 58 and 62 engage the chain on its inner side. This manner of
coupling sprocket 73 to chain 63 permits the sprocket to rotate in the opposite direction from sprockets 62 and 58 when chain 63 is being driven. The preferred form of clutch is a magnetic type of clutch. The details of construction of automatically operable clutches, such as magnetic clutches, do not constitute a part of this invention and are well known to those skilled in the art. Connects the reversely driving nut shaft to the flywheel, translating the reverse motion of the nut shaft and permitting the nut shaft to drive the flywheel in the same manner as it is normally driven by the prime mover. If coiling 92 is energized before the angular velocity of the nut shaft is equal to the corresponding angular velocity at which flywheel 52 is normally driven by the prime mover, a load will be placed on the flywheel causing the prime mover to supply power to the nut shaft during a portion of the downstroke. If coil 92 becomes energized when the angular velocity of the nut shaft is greater than that of flywheel 52, then the nut shaft will drive the flywheel. In either instance clutch 70 will be subjected to strain at the time of engagement that becomes more severe as the difference between the angular velocities of the nut shaft and flywheel increases. The preferred procedure is to position limit switch 85, with respect to the engaging member on pump screw shaft 16, so that it will be closed and energize actuating coil 92, engaging clutch 70, when the angular velocity of the flywheel corresponds to the angular velocity of the counter-revolving nut shaft; at this instant clutch 70 can be engaged without subjecting it to undue strains. If a highly viscous material is to be pumped, considerable resistance to the downward movement of the lifting assembly will be encountered and it may become necessary to supply energy from the prime mover and flywheel during the downstroke. In this event clutch 70 will become engaged early in the downstroke and limit switch 85 will be positioned accordingly.

Near the end of the downstroke the engaging member on pump screw shaft 16 contacts normally closed limit switch 90, separating the contact points. This interrupts the circuit and the reverse, or downstroke clutch actuating coil 92 and holding coil 88 are de-energized causing clutch 70 to become disengaged and opening limit switch 85.

The engaging member on pump screw shaft 16 continues to move downwardly and in passing contacts normally open limit switch 75 opening it still further as it moves past it. Head 29 secured to the end of pump screw shaft 16 next engages the end of neck 38 of pressure plate 37 and the momentum of the downwardly moving mass forces neck 38 and pressure plate 37 downwardly, compressing springs 35 and 36, and arresting the downward progress of descending pump screw shaft 16. The energy thus stored in springs 35 and 36 is released against the pressure plate 37 as soon as the downward movement of the pump screw shaft ceases, forcing neck 38 violently upward and causing head 39 to engage the nut of pump screw shaft 16 to move upwardly. This causes the engaging member to again contact normally open limit switch 75, closing the points and again completing the circuit through the forward or upstroke clutch actuating coil 83 and holding coil 79. This re-engages clutch 59, again connecting nut sleeve element 17 to flywheel 52. Since flywheel 52 is traveling at a considerably greater angular velocity than that at which it is normally driven by prime mover 51, the kinetic energy stored in the flywheel will serve to drive the nut shaft causing nut sleeve element 17 to rotate and raise pump screw shaft 16.

From the above description it is seen that during a portion of the downstroke and a portion of the upstroke prime mover 51 may be temporarily disconnected from the more rapidly revolving flywheel by means of the overrunning clutch 53 and is under no load. As the pump
screw shaft continues to rise, the energy stored in the flywheel 52 is applied to raising the pump screw shaft thereby progressively reducing the angular velocity of the flywheel until it again coincides with the corresponding angular velocity of the prime mover. At this point overrunning clutch 53 automatically connects the prime mover to the flywheel and the prime mover continues to supply additional power to raise the pump screw shaft for the remainder of the upstroke, thereby starting a new cycle.

Fig. 4 represents a modification of the pumping mechanism shown in Fig. 1. In this embodiment two ball bearing screw jacks are employed. The two pump screw shafts 101 and 102 are the rotating members and are restrained from longitudinal movement while the two nut sleeve elements 103 and 104 move longitudinally. Since nut sleeve elements 103 and 104 are coupled together by yoke 105, no rotation can occur in either nut screw element.

The screw members are rotatably mounted at each end on frictionless bearings supported in bearing retainers 106, 107, 108 and 109. Bearing retainers 106 and 107 are secured to an upper platform 110 and bearing retainers 108 and 109 are secured to an intermediate platform 111. Both platforms 110 and 111 form a part of supporting frame work 112.

The lower portion of one of the pump screw shafts, for example shaft 102 is provided with a suitable transmission means such as a bevel gear 113 secured to pump screw shaft 102. A corresponding bevel gear 114 is secured to a shaft 115 journals in bearings retained in a bearing retainer 116 securely attached to supporting frame work 112 and positioned to permit gear 114 to properly engage gear 113. The other end of shaft 115 is secured to one of flexible coupling 43. Shaft 115 corresponds to shaft 41 of the embodiment shown in Fig. 1. A transmission means such as a chain sprocket 117 is secured to screw member 102. A second and corresponding sprocket 118 is secured to screw member 102 and positioned to be in alignment with sprocket 117. A chain 119 engages sprockets 117 and 118 and synchronizes the rotation of the two pump screw shafts.

A third platform 120 is located above the transmission mechanism and provided with suitable spring retainers that support springs 121 and 122. The spring retainers are provided with an axial bore large enough to permit free passage of the pump screw shafts. The upper end of springs 121 and 122 are provided with a pair of pressure plates 123 and 124 having an axial bore extending therethrough, large enough to permit free passage of pump screw shafts 101 and 102. Springs 121 and 122 serve a similar function as springs 35 and 36 in the directly responsive auxiliary energy accumulator and braking mechanism shown in Fig. 1, the only difference being that the lower end of the nut sleeve elements engages the compression member instead of head 39 as in Fig. 1.

The end of a polish rod 126 at the upper end of a sucker rod string (not shown) is secured to yoke 105 and positioned to align the polish rod 126 over tubing 12. Platforms 111 and 120 are provided with clearance holes to permit free passage of polish rod 126. Base 128 of framework 112 is secured to tubing 12. The sides of framework 112 may be covered with sheathing if desired to exclude dirt and sand from the screw jack and transmission mechanisms. The transmission means and prime mover assembly required to operate the device shown in Fig. 4 can be the same as that shown in Fig. 2 with shaft 115 connected to the flexible coupling instead of shaft 41.

From the foregoing description it will be apparent that I have provided a novel pumping mechanism capable of utilizing a substantial part of the kinetic energy developed during the downstroke, by storing the energy in a flywheel and using the stored energy to raise the reciprocating element or the screw jack during the upstroke, thereby reliving the prime mover of an appreciable portion of the load to which it would be otherwise subjected. My assembly permits the prime mover to operate at substantially no load during the majority of the downstroke and for a portion of the upstroke thereby conserving energy.

An inherent feature of the ball bearing screw jack mechanism is that the transmission is substantially frictionless. This factor permits the revolving element to efficiently drive the longitudinally moving member, such as during the upstroke, and permits the downwardly moving member, on the reverse stroke, to effectively drive the revolving member.

My novel pumping system reduces the peak load requirements normally encountered in existing systems, thereby permitting the use of a prime mover of smaller capacity.

My novel pumping mechanism does not require counterbalances, therefore the inertia of the mass in motion is reduced to a minimum.

It is contemplated that modifications of the elements used in the pumping mechanism may be also employed, for example the ball bearing screw jack may have a single, double, or triple groove construction and the co-acting members may be enganged by balls that are of uniform diameter, or the balls may vary in size and be arranged in the grooves in proper sequence. Likewise any other satisfactory driving or transmission means, capable of performing the functions described, may be substituted.

It is understood that other directly responsive energy accumulator means shown in Fig. 1 may be used in place of the exemplary spring and pressure plate arrangement shown, and such other accumulator means may include compressible fluids such as air or gas in which energy may be stored and then released.

Having described in an exemplary manner my invention, it is to be understood that it is not intended to limit the scope of the invention to the exact details set forth herein which may be varied without departing from the spirit of the invention as set forth in the appended claims.

I claim:

1. A long stroke pumping mechanism according to claim 1 wherein the forward and reverse driving clutch means are magnetic.

2. A long stroke pumping mechanism according to claim 2 wherein the forward and reverse driving clutch means are magnetic.

3. In a long stroke pumping mechanism, the combination of: a prime mover; a flywheel coupled to said prime mover through an overrunning clutch; a ball bearing screw jack comprising a rotatable nut member and a longitudinally movable screw member; a forward driving clutch means and transmission means connecting said nut member to said prime mover when said forward driving clutch is engaged; a reverse driving clutch means and transmission means reversely engaging said nut member with said flywheel when said reverse driving clutch is engaged; and means controlled by longitudinal movement of said screw member for engaging and disengaging said forward and reverse driving clutch means;
and a braking and resilient energy storing means engageable by said screw member whereby downward movement of the screw member is arrested and energy is stored in said resilient energy storing means, said energy storing means returning said stored energy to said screw member after said screw member has come to rest, to initiate upward movement of said screw member.

4. A long stroke pumping mechanism comprising: a prime mover; a flywheel coupled to said prime mover through an overrunning clutch, said flywheel being mounted on a first shaft; a countershaft provided with a first clutch means; a nut shaft provided with a second clutch means; transmission means connecting said first shaft and countershaft for direct connection; transmission means connecting the countershaft with the nut shaft through said first clutch means; transmission means connecting the nut shaft reversely through said second clutch means to said direct connection transmission means connecting said first shaft and countershaft; a ball bearing screw jack comprising a vertically movable screw member and a rotatable nut member; transmission means connecting said nut member to said nut shaft; means controlled by longitudinal movement of said screw member for engaging and disengaging said first and second clutch means; a braking and resilient energy storing means engageable by said screw member, whereby the downward movement of the screw member is arrested and energy is stored in said resilient energy storing means, said resilient energy storing means returning said stored energy to said screw member, after said screw member has come to rest, to initiate upward movement of said screw member.

6. Means for imparting to and storing energy from a vertically reciprocating means comprising, in combination: a prime mover and a flywheel; antifriction screw means including a vertically reciprocating nonrotating screw member and a driving nut means associated therewith, said screw member and said nut having cooperable complementary spiral grooves, ball bearings antifrictionally connecting said screw member and said nut means and movable in said grooves, and means for circulating said ball bearings; means for holding said nut means against longitudinal movement; drive means for rotating said nut means and including a first clutch means connecting said nut means with said prime mover whereby rotation imparted to said nut means raises said screw member; a second clutch means associated with said nut means and said flywheel, said second clutch means being adapted to transfer energy from rotation of said nut means upon descent of said screw member to said flywheel above a predetermined speed of rotation; means positioned along the path of descent of said screw member for disconnecting said second clutch means from said flywheel; directly responsive accumulator energy means for cushioning and stopping descent of said screw member and for storing energy imparted thereto by said falling screw member to immediately impart upward movement to said screw member; means for imparting energy stored in said flywheel to said screw member at a selected point along its ascending path and until transfer of said stored energy is decreased to a preselected value; and means for then operatively connecting said prime mover through said first clutch means to said driving nut means for imparting energy to said screw member to continue ascent thereof at a preselected rate.

7. Means for imparting to and storing energy from a vertically reciprocating means comprising, in combination: a prime mover and a flywheel; antifriction screw means including a vertically reciprocating nonrotatable screw member and a rotatable nut means cooperatively associated therewith; means for holding said rotatable nut means against longitudinal movement, first means releasably coupling said nut means to said prime mover; means for reducing said stored energy to said screw member until transfer of said stored energy is decreased to a preselected value; second means releasably coupling said nut means to said flywheel; said second releasably coupled means being operative to connect said nut means and said flywheel to impart energy from rotation of said nut means upon descent of said screw member to said flywheel above a predetermined speed of rotation; means to stop descent of said screw member and to initially impart upward movement to said screw member; said second releasably coupled means being operative to connect said nut means and said flywheel until energy thereby imparted to said screw member reaches a predetermined value; said first means releasably coupled to said nut means being then operative to connect said prime mover to said nut means for imparting energy thereto to continue ascent of said screw member at a preselected rate.

8. In a long stroke pumping mechanism, the combination of: a prime mover; energy storing means; an overrunning clutch coupled to said prime mover; a ball bearing screw jack means including a rotatable member and a longitudinally movable member; a first clutch means and associated transmission means connecting said rotatable member to the prime mover when said first clutch means is engaged; a second clutch means and associated transmission engaging said rotatable member with the energy storing means when said second clutch means is engaged; and means selectively connectable by longitudinal movement of the longitudinally movable member for engaging and disengaging said first and second clutch means.

References Cited in the file of this patent

UNITED STATES PATENTS

760,577 Sprung May 24, 1904
1,216,415 Cartmell Feb. 20, 1917
1,435,892 Cole Nov. 16, 1922
1,789,975 Heil Jan. 27, 1931
1,913,663 Ferris June 13, 1933
2,004,050 Brown June 4, 1935
2,205,333 Baer June 18, 1940
2,260,671 Humphrey Oct. 28, 1941
2,780,261 Pounds July 20, 1957
2,324,211 Hodgson et al. July 13, 1943
2,446,393 Russell Aug. 3, 1943
2,519,871 Begerow Aug. 22, 1950
2,623,403 Terdina Dec. 30, 1952
2,629,264 Kran Feb. 24, 1953
2,676,352 Moore Apr. 27, 1954