No. 676,401. Patented June 11, 1901.

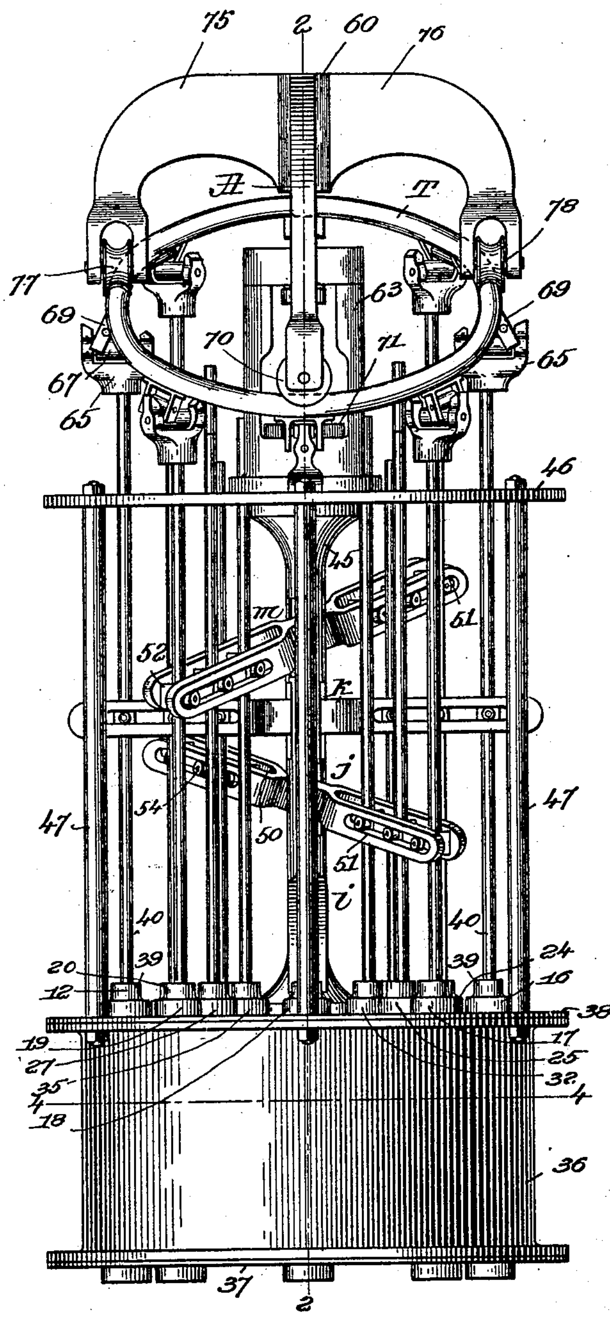
K. O. B. TEXTORIUS.

AIR COMPRESSION APPARATUS.

(Application filed Jan. 5, 1900.)

(No Model.) 3 Sheets—Sheet 1.

Fig. 1.



Witnesses:
George L. Dolbeare
Fred S. Gruenbaf

Inventor:
Knut O. B. Textorius.
By Crosby Gregory, attys.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

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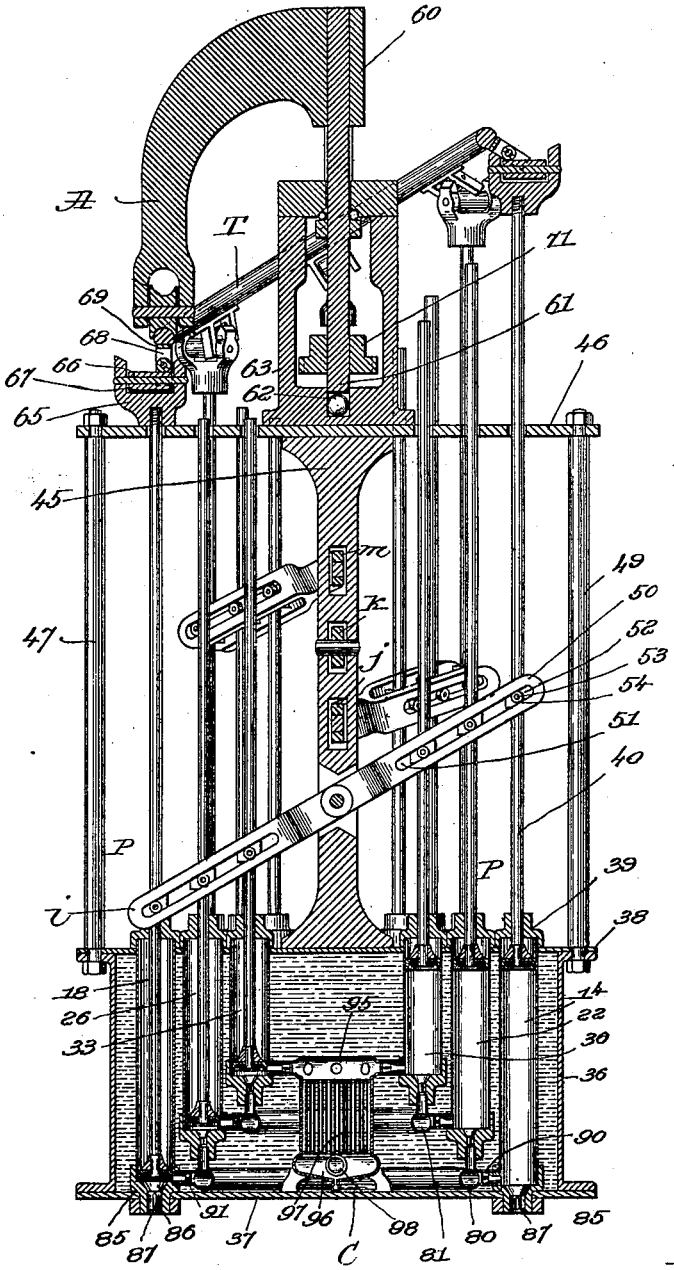
(No Model.) 3 Sheets—Sheet 2.

Fig. 2.



Witnesses:
George L. Dolbeare
Fred S. Grumbof.

Inventor:
Knute O. B. Textorius.
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Fig. 3.

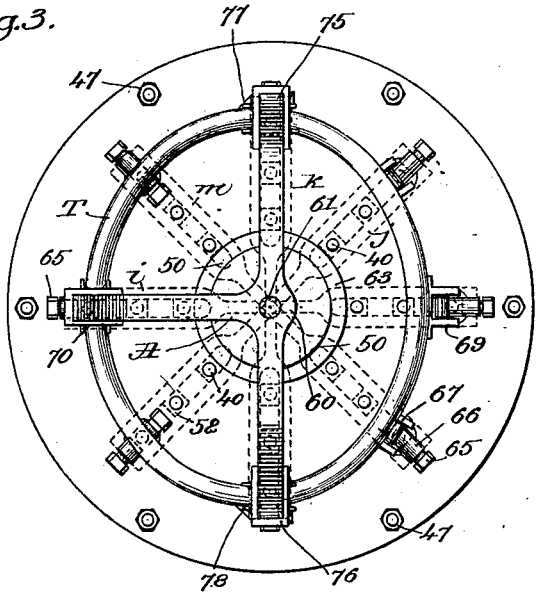


Fig. 4.

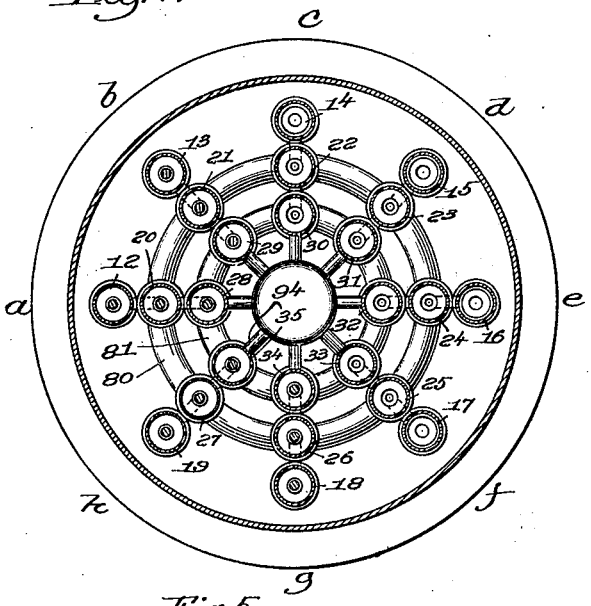
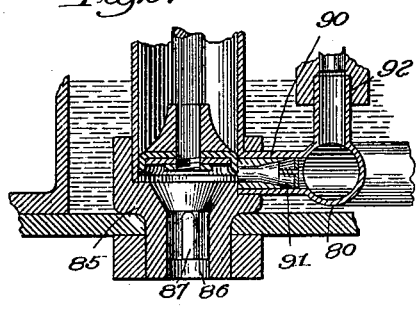


Fig. 5.



Witnesses:
George L. Dolbeare.
Fred S. Grundel

Inventor
Knut O. B. Textorius
by Crosby Gregory
Attys.

UNITED STATES PATENT OFFICE.

KNUT O. B. TEXTORIUS, OF BOSTON, MASSACHUSETTS, ASSIGNOR OF NINE-TWENTIETHS TO JOHN J. HOWARD, OF SAME PLACE.

AIR-COMPRESSION APPARATUS.

SPECIFICATION forming part of Letters Patent No. 676,401, dated June 11, 1901.

Application filed January 5, 1900. Serial No. 500. (No model.)

To all whom it may concern:

Be it known that I, KNUT O. B. TEXTORIUS, a subject of the King of Sweden and Norway, residing at Boston, county of Suffolk, and State of Massachusetts, have invented an Improvement in Air-Compression Apparatus, of which the following description, in connection with the accompanying drawings, is a specification, like characters on the drawings representing like parts.

This invention relates to an air-compressing apparatus; and it includes certain broadly-novel features, simple and convenient forms of which are illustrated and will be hereinafter described, and the construction is such that I can compress or condense air to a very great extent without the loss of any of its expansive property or effect, and this result can be accomplished with facility and rapidity and by the employment of a minimum amount of actuating force.

The apparatus involves in its construction an air-compressor having a shiftable element, an actuator for said shiftable element mounted for turning movement and fixed against movement in a direction transverse to its axis of motion, and means between the actuator and said shiftable element for transmitting the effect of the former to the latter. The air-compressor hereinafter described consists of a cylinder, and the piston thereof constitutes the movable element of the device, and as a means for multiplying the output of the machine I prefer to employ a plurality of these air-compressors operable in sets, the construction being such that the respective sets will be operated in succession by a single actuator.

My improved apparatus includes as another feature a plurality of communicating tanks, shown as cylinders, of progressively-decreased cubical containing areas, pistons, or other compressing devices in the tanks or cylinders and means for alternately advancing said pistons, whereby the compressed air from a primary cylinder will be discharged into a second cylinder of less cubical area, thereby materially condensing or compressing the air, which is a feature of great utility.

Another peculiar feature of the invention consists in providing a cooling tank or apparatus to inclose the compressing cylinder or cylinders, such cooling apparatus being adapted to receive a body of water or the like the purpose of which is to withdraw as far as possible the heat created in the several pistons, so that the compressed air at its point of discharge will be of the maximum efficiency, the expansive capacity of the air at such point being thereby utilized.

In the drawings, Figure 1 is a side elevation of an air-compressing apparatus constructed in accordance with my invention in a simple and convenient embodiment thereof. Fig. 2 is a sectional side elevation of the same, the section being taken on the line 2 2, Fig. 1, and looking toward the left. Fig. 3 is a plan view of the apparatus. Fig. 4 is a horizontal sectional plan view, the section being taken in the line 4 4, Fig. 1; and Fig. 5 is a detail of the valve mechanism hereinafter more particularly described.

The apparatus in the embodiment thereof illustrated in the drawings involves a plurality of air-compressors each consisting, preferably, of a cylinder and a piston, and the pistons are shown as movable for the purpose of compressing the air. Upon inspection of Fig. 4 it will be seen that the air-cylinders are arranged in circular series, and they are arranged in sets of three each so disposed that the first one of each set will discharge into the second one, and said second one will deliver to the third and the third one into a receptacle common to all the final cylinders. The sets are disposed radially of the respective circles, the latter being concentric with each other. Upon inspection of Fig. 4 it will be seen that the air-cylinders are disposed in three circles—eight in each circle—and the outer cylinders constitute the primary ones, the intermediate the second ones, and the innermost ones the final ones. The outermost cylinders are designated, respectively, at 12, 13, 14, 15, 16, 17, 18, and 19, the intermediate by 20 21 22 23 24 25 26 27, and the final ones by 28, 29, 30, 31, 32, 33, 34, and 35. As will hereinafter appear, the mechanism is of such a construction that the tank or cylinder 20 will discharge into a diametrically opposite and intermediate tank 24 and the latter in turn into the innermost and diametrically op-

posite tank 28, the pistons being successively effective, and those pistons which are intersected by common radial lines will be connected by movement in unison. The several circularly-disposed cylinders are inclosed by the cylindrical wall 36, bolted or otherwise secured to the base and top plates 37 and 38, respectively, said wall and plates forming a chamber to receive water or some other cooling medium to act against all the cylinders, so that the latter will be cooled as far as possible. The heads or tops of all the cylinders, it will be seen upon examination of Fig. 2, extend through the top plate 38 of the water-chamber just alluded to, and they are provided with stuffing-boxes (each designated by 39) through which the rods (each designated by 40) of the pistons P extend. The cylinders extending inward are of progressively-decreased areas, so that when the first one of a set discharges its contents into the second one the compression will be materially increased upon the action of the second one, and this effect will be multiplied correspondingly by the third one. The air-compressors (see Fig. 4) are arranged in series of three, each radially around the center of the apparatus, and for convenience I have denoted these series by *a b c d e f g h*, and the pistons of the series *a* and *e* are connected for movement in unison, while the pistons for the series *b* and *f* are likewise connected, and so on with the remainder of them, and a convenient means of connecting them is by means of walking-beams or rockers, four of these, as is evident, being necessary. A standard is shown at 45, mounted upon the plate 38 and surmounted by the top plate 46, both of these plates being circular in outline and being united by the tie-bolts 47. The piston-rods 40 are of progressively-decreased lengths from the outer to the innermost, and they are shown as vertically disposed and as extending through properly-positioned guide-openings in the top plate 46, such plate serving to prevent lateral motion of the rods. The respective and diametrically opposite sets of piston-rods are connected, as hereinafter stated, for movement in unison, and I have represented for this purpose four superposed walking-beams or rockers, the same being denoted by *i*, *j*, *k*, and *m*. The rocking beam *i* connects the piston-rods of the cylinders 18, 26, and 33 and 30, 22, and 14, while the walking-beam *j* connects the rods of the cylinders 13, 21, and 29 and 32, 25, and 17, and so on. The walking-beams *i*, *j*, *k*, and *m* are fulcrumed upon the vertical standard 45 and in such a manner that they will not interfere with each other, the arrangement thereof being staggered. The walking-beams at opposite sides of their axes are bifurcated, as at 50, and the branches of the respective bifurcations are longitudinally slotted, as at 51, to receive projections of suitable kind extending oppositely from the piston-rods, whereby the rods will be coupled to the walking-beams. Said piston-rods are shown as furnished with clamping-collars 52, each equipped with oppositely-disposed pivots 53, carrying antifriction-rolls 54, the antifriction-rolls being adapted to fit and slide within the adjacent longitudinal slots 51 of the coöperating walking-beams. It will be remembered that the series of cylinders *a* and *e*, *b* and *f*, &c., or those arranged diametrically opposite each other are connected for movement in unison, and I prefer to successively operate the outermost piston-rods by suitable actuating means in such manner that the pistons of the diametrically-alined cylinders upon one side of the center of the apparatus will be at their lowest points, while the corresponding pistons upon the opposite side of such cylinder will be at their highest points, and the piston-rod-actuating means is shown comprising a track sustained by the outermost rods, though this is not essential, and an actuator adapted to travel upon said track to vibrate the same, whereby the piston-rods will be reciprocated in proper order, said actuator being preferably held against movement transverse to its axis of motion and serving to engage the track as it rotates, and the latter is preferably annular and supported freely of the piston-rods. The actuator for the piston-rods is denoted by A, and it consists of a curved arm adapted to bear upon the annular track T. The actuator is represented as consisting of a curved arm movable about a vertical axis and having in the present case a center hub or body 60, secured to the upper end of the shaft 61, said shaft being supported by an antifriction-bearing 62 upon the casting 63, sustained by the top plate 46. The actuator is fixed to the shaft 61, so that upon the travel of said actuator upon the track it will oscillate said track, thereby effecting the proper operation of the piston-rods. The outermost piston-rods at their upper ends have secured thereto the U-shaped members 65, the branches of which are united by the spindles 66, upon which the antifriction-rolls 67, supported between the bifurcated portions 68 of the bifurcated arms 69, extending diametrically downward and outward from the annular and angularly-mounted track T, are adapted to roll. The actuator is provided at its lower or working end with the antifriction-roll 70, adapted to run upon the track T, and the two rolls just described reduce friction between the parts. The track T as it is vibrated by the rotative actuator A, which is fixed against vertical movement, serves by its bifurcated arms 69 straddling the spindles 66 to successively reciprocate the outermost piston-rods 40, and as the piston-rods are connected in series of six—three at each side of the standard 45—it will be apparent that the rods at one side of said standard will be down while those upon the other side of the standard will be up, and this relation will continue during the rotation of the actuator.

Any convenient means may be provided for

rotating the vertical shaft 61. For this purpose I have shown the gear 71, adapted to be connected by gearing (not shown) with some convenient kind of motor which serves to continuously rotate the shaft.

In connection with the apparatus means of a suitable nature will be provided to prevent the track T from tipping or being displaced from the piston-rods, which freely sustain the same. The means illustrated for preventing the track from tipping consist of the arms 75 and 76, (see Fig. 1,) extending oppositely from the hub 60 of the actuator and at right angles to said actuator, said arms, as will be evident, being shorter than the actuator-arm A. The arms 75 and 76 are provided at their lower ends with antifriction-rollers 77 and 78, adapted to ride upon the tracks. The arms 75 and 76 in addition to serving as guides to prevent the track from tipping also impart an actuating force to said track for the purpose of depressing the pistons. The outer circle of air-cylinders discharge their contents into the annular pipe 80, common to them all, from which the air flows into the intermediate series of cylinders through said pipe. The air from the intermediate circle of cylinders passes into the annular pipe 81, common to them all, and from thence into the cooling chamber or receptacle C, and as the cylinders are of progressively-decreased area interiorly it will be evident that the air when it reaches the final or cooling chamber C will be under very high compression.

Valve-casings, as 85, are secured to the lower ends of the outermost cylinders and extend through the floor or bottom 37 of the water-chamber which houses the cylinders. (See Figs. 2 and 5.) These casings are bored vertically, as at 86, the upper ends of the bores being tapered to receive the inlet-valves 87. This construction is a common type of controlling means for an air-compressing device, and hence it is deemed unnecessary to furnish a more detailed description thereof, except when the outermost pistons ascend the valves will be raised in proper order, thereby permitting the influx or admission of air, which is cut off by the falling valves as soon as the pistons descend. The outermost cylinders are connected by short pipes, as 90, with the annular pipe 80, and they inclose spring-actuated valves 91, of suitable construction, adapted to open under the pressure of the air from the said cylinders to admit the same into the pipe 80, from whence it can pass through pipes, as 92, into the proper intermediate cylinders. The intermediate cylinders are connected by pipes, as 93, with the annular pipe 81, and the latter in turn communicate by short pipes, as 94, with the upper end of the cooling-chamber C, which, it will be seen upon reference to Fig. 2, is inclosed by the water-chamber. The storage-chamber C includes two compartments 95 and 96, united by a multiplicity of vertical pipes 97, which can be surrounded by the water in the water-chamber. The air from the inner circle of cylinders is received by the chamber C through the pipe 94, the latter being provided with spring-controlled inlet-valves 97', like those previously set forth, to govern the admission of air. The air first enters the compartment 95 and then passes through the pipes 97 and into the compartment 96, where it can be drawn off through the pipe 98 for power or other purposes.

As previously set forth, the apparatus involves air-compressors disposed in sets of three, the first one being adapted to deliver its contents into the second one and the second into the third and the third one into the cooling-chamber C.

In Fig. 2 the actuator A is shown as being located in vertical line with the piston P of the cylinder 18, and it will also be seen that what is shown as the left-hand end of the walking-beam *j*, which controls the pistons of the cylinders 13, 21, 29, 32, 25, and 17, is down to its lowest limit, by reason of which the pistons of the left-hand series of cylinders will be down, while those of the right-hand series will be up. Let it be assumed that the shaft 61 is being rotated and as it moves it lowers successively different portions of the track T, the result being that the two sets of pistons will be operated in unison, those on the left being elevated, while those on the right are lowered. The action of the ascending pistons causes them to draw in air. The piston of the cylinder *a* as it rises draws in a supply of air from the atmosphere, while the piston of the cylinder 16 as it descends forces its condensed air into the pipe 80, from whence it passes into the cylinder 20, the piston of which at this time is ascending. Upon the descent of the piston of said cylinder 20 its condensed air will be forced into the pipe 81 and from thence into the diametrically opposite cylinder 32. I have described the action of one of the walking-beams and a set of compressor devices controlled thereby, and it will be evident that the same action is duplicated with respect to the other compressor devices and their operating walking-beams or rockers.

The invention is not limited to the embodiment of any of the parts previously set forth nor to their arrangement, for these parts may be variously modified within the scope of the appended claims.

Having fully described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In an apparatus of the class specified, air-compressors in communication with each other and each having a piston and piston-rod, an annular track sustained by certain of said piston-rods, walking-beams connecting said piston-rods for movement in unison, an actuator adapted to travel upon said track and held rigidly in one and the same plane of movement, and means for preventing said track from tipping during the operation of the actuator.

2. In an apparatus of the class specified, air-compressors in communication and each having a piston and piston-rod, walking-beams connecting the piston-rods in sets, a track sustained by certain of said piston-rods, a shaft provided with an actuator extending rigidly therefrom for engaging said track, and an arm or arms also extending rigidly from said shaft for engaging the track to prevent it from tipping during the motion of the actuator.

3. In an apparatus of the class specified, air-compressing cylinders arranged in a plurality of communicating series, one series within another, and of different capacities, connecting-pipes connecting said series, each cylinder having an air-compressing piston and piston-rod, each series being adapted to deliver its contents into a pipe communicating with the succeeding series, walking-beams connecting the opposite piston-rods, and means for rocking said walking-beams.

4. In an apparatus of the class specified, a circular series of air-compressing cylinders each having a piston, an annular pipe connected with said series for conducting the partially-compressed air to a second series of cylinders, said second series of circularly-disposed air-cylinders having smaller capacity than said first series, each cylinder including a piston, and means for operating the pistons in sets.

5. In an apparatus of the class specified, a circular series of air-compressors each having a piston, an annular pipe connected with said series of compressors, a second series of circularly-disposed air-compressors, partially-compressed air being conducted by said pipe from the first series to said second series of compressors, each having less capacity than the first series, and each including a piston, means for operating said pistons in unison in pairs, one in each series, and the pairs in succession throughout the series, a chamber located to receive compressed air from the inner series of air-compressors, and including two distinct but connected compartments, and a series of pipes connecting the said compartments, and cooling means inclosing said chamber.

6. In an apparatus of the class specified, a water chamber or tank, a plurality of circularly-disposed series of cylinders inclosed by said water-chamber, the cylinders of each series having the same capacity, and the separate series of cylinders having different capacities, connections between said respective series of cylinders, the connections being from the largest progressively to the smallest, a cooling-chamber also in said tank to receive compressed air, said cooling-chamber being connected to the series having the smallest capacity, pistons and piston-rods for each of the cylinders, a standard mounted on said water-chamber, a series of walking-beams each fulcrumed between its ends upon said standard and connected at each side of said standard with adjacent piston-rods in sets, whereby the inward movement thereby of the piston of a large cylinder simultaneously causes an outward movement of a piston of a smaller cylinder, thereby permitting the compressed air from the large cylinder to pass across and into said opposite smaller cylinder, and upon the reverse movement of said walking-beam permitting the compressed air from said smaller cylinder to pass across and into an opposite and still smaller cylinder, a track freely sustained upon the piston-rods of one of said series, and an actuator mounted to roll upon said track for actuating, through said track and said walking-beams, all of said pistons.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

KNUT O. B. TEXTORIUS.

Witnesses:
HEATH SUTHERLAND,
MABEL PARTELOW.