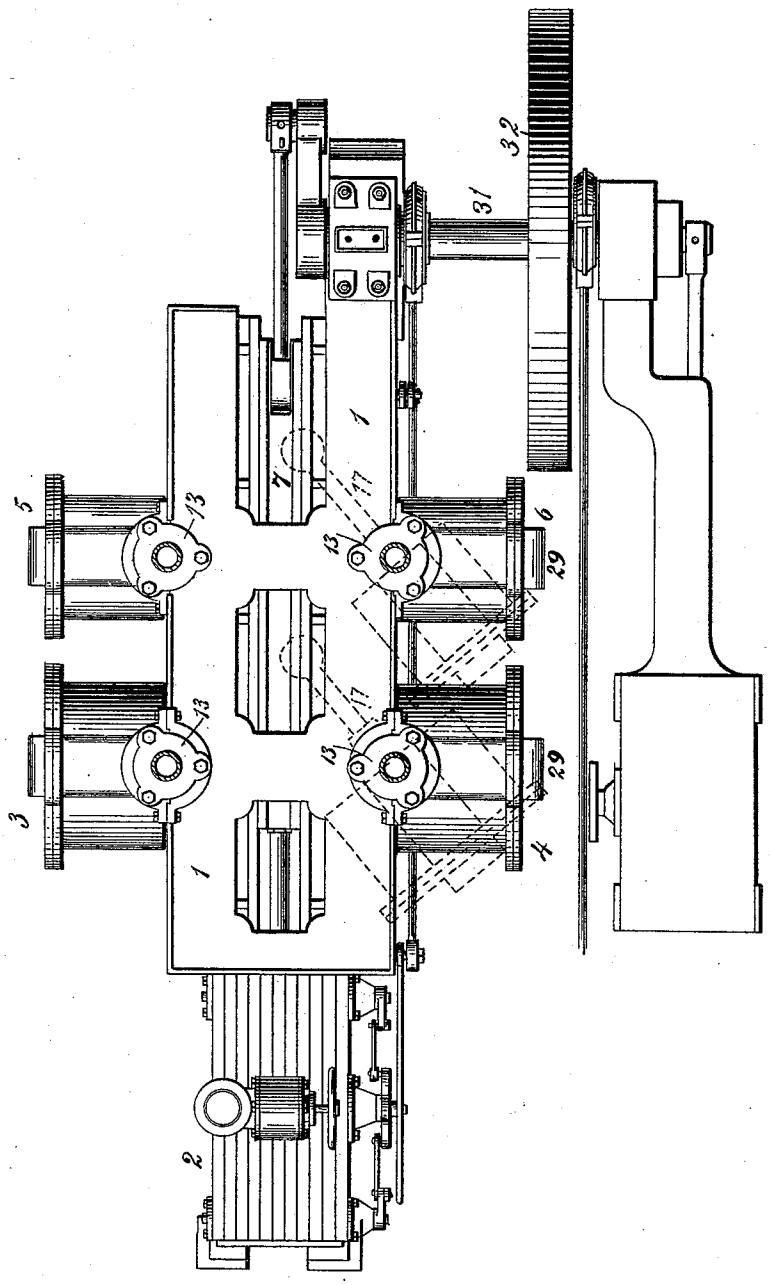
(No Model.) 4 Sheets—Sheet 1.

J. CRABTREE.

AIR OR GAS COMPRESSOR.

No. 594,524. Patented Nov. 30, 1897.

Fig. 1.



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(No Model.) 4 Sheets—Sheet 2.

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Fig. 2.

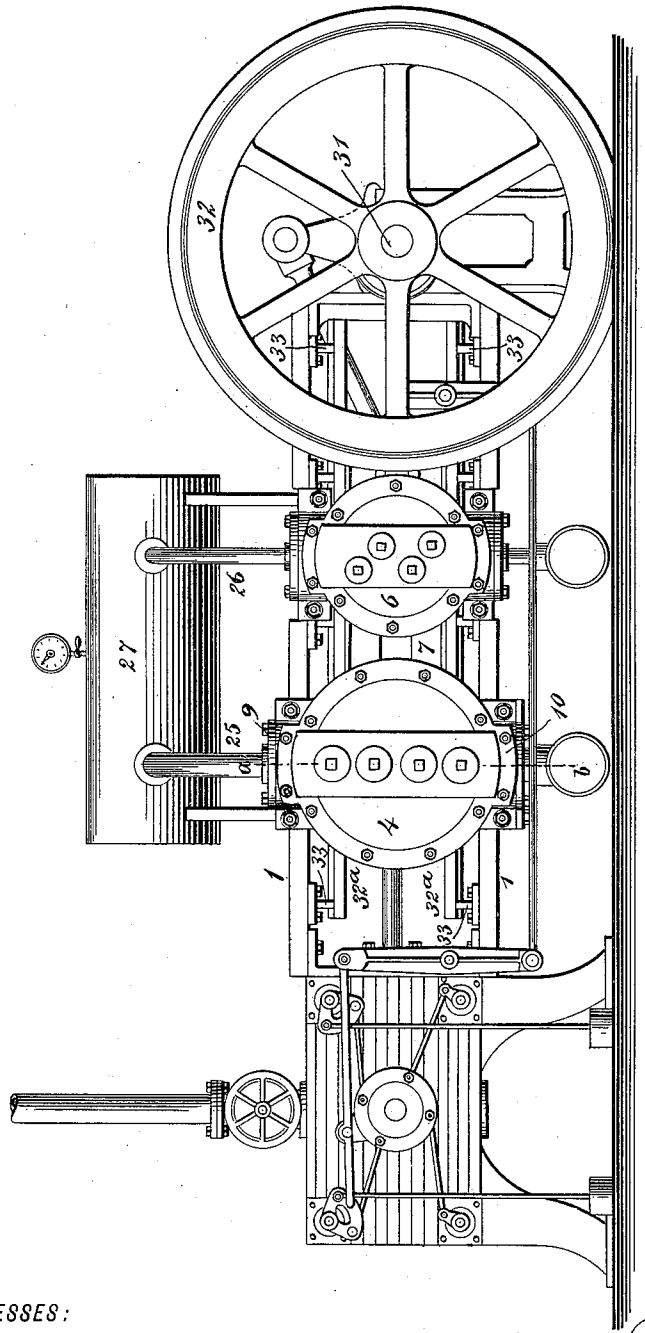

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Fig. 3.

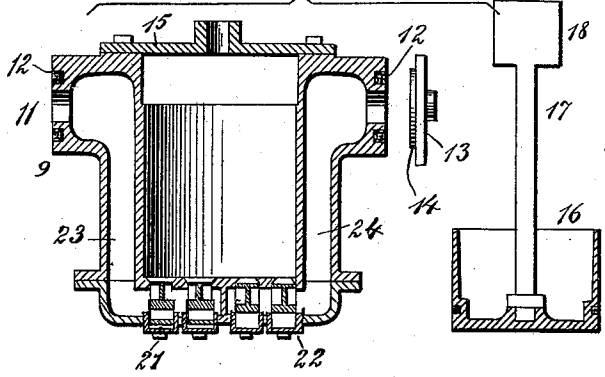


Fig. 4.

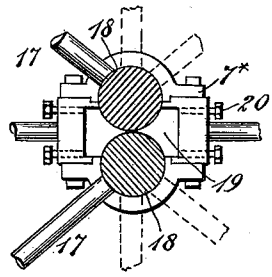


Fig. 5.

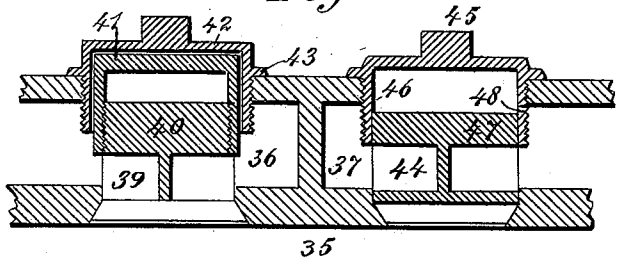


Fig. 9.

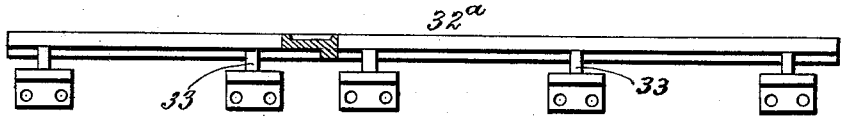


Fig. 6.

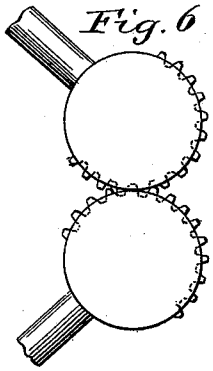


Fig. 7.

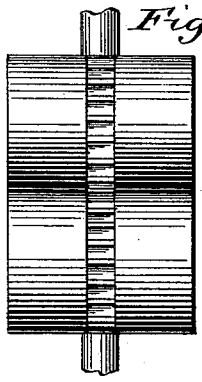
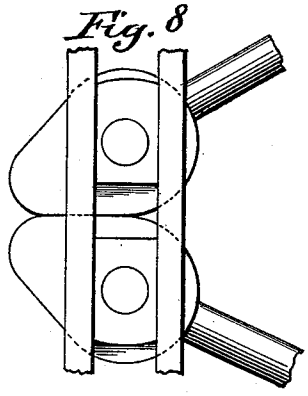


Fig. 8.



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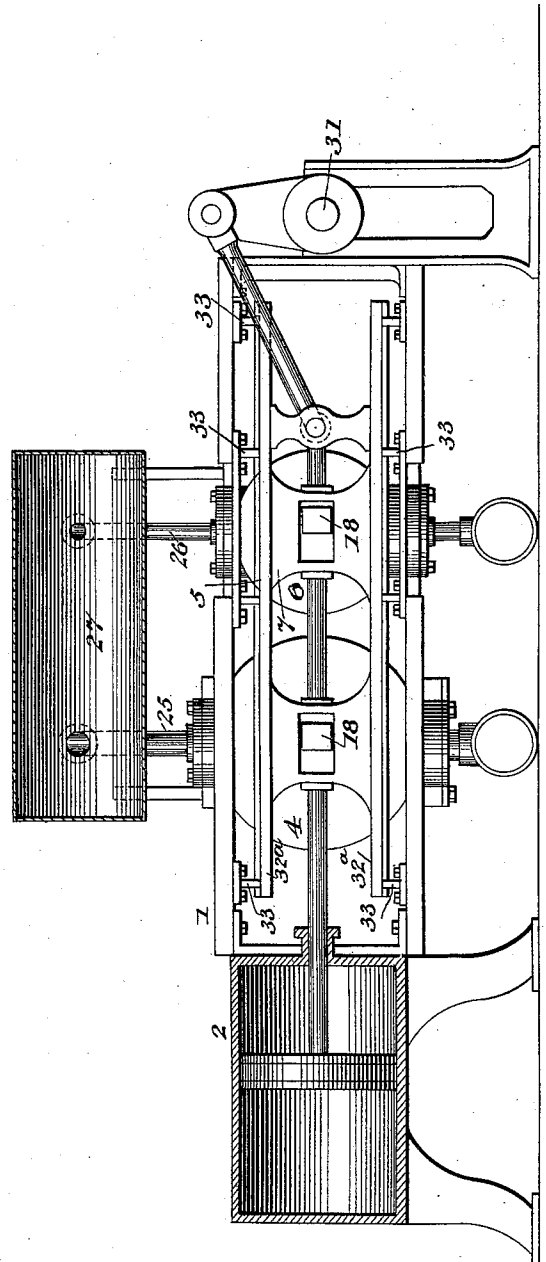

Fig. 10.

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UNITED STATES PATENT OFFICE.

JONAS CRABTREE, OF NEW YORK, N. Y.

AIR OR GAS COMPRESSOR.

SPECIFICATION forming part of Letters Patent No. 594,524, dated November 30, 1897.

Application filed April 13, 1896. Serial No. 587,313. (No model.)

To all whom it may concern:

Be it known that I, JONAS CRABTREE, a citizen of the United States, residing in the city of New York, in the county and State of New York, have invented a certain new and useful Improvement in Air or Gas Compressors, of which the following is a specification.

The subject of the present invention is an improved machine for compressing air, gas, or other fluid, and is principally designed to secure economy of working energy and the most advantageous application of the actuating power and attain simplicity of construction and reduction of weight in the moving and other parts of the machine.

As will further appear, the improved compressor also embodies certain novel details and parts which contribute to high efficiency of operation.

The accompanying drawings form a part of this specification and represent what I consider the best means of carrying out the invention.

Figure 1 is a plan view showing my improved compressor. It also shows in outline on its lower side an additional engine to be operated by the subsequent expansion of the air which has been compressed. Fig. 2 is a view representing in side elevation one form of compressor embodying my improvements. Fig. 3 is a detail sectional view of one of the compressing-cylinders and its trunnions, the section being taken in the plane indicated by the dotted line *a b* in Fig. 2. Fig. 4 is a horizontal sectional view through the inner connection with the slide-bar of one pair of heads of the rods attached to the compressing-piston, and Fig. 5 is a detail sectional view showing on an enlarged scale the construction and arrangement of the supply and delivery valves of one of the compressing-cylinders. Fig. 6 is an enlarged detail sectional plan view showing the heads of the piston-rod as of gear form. Fig. 7 is a detail view of the parts shown in Fig. 6, but represented in different position. Fig. 8 is a somewhat similar view, but illustrating the employment of elliptical heads for increasing the stroke of the compressing-pistons. Fig. 9 is a view of the guides detached.

Similar reference-numerals indicate corresponding parts in all the figures where they appear.

The framework 1 is suitably bolted to the rear end of the steam-cylinder 2, which may be of the Corliss or other approved style. The said frame is so constructed that its main parts can be adjusted for compressors of varying size.

3 and 4 designate the primary and 5 and 6 the secondary compression-cylinders, which as represented are of single-acting and oscillating character and are relatively located with regard to each other and the slide-bar 7, (reciprocated by the steam-piston,) as most clearly shown in Fig. 1. While I have shown four of such cylinders, it will be obvious that for the purpose of securing high compression their number may be increased to any desired extent.

Each of the compression-cylinders is pivotally mounted in bearings contiguous to its inner end and is provided with upper and lower trunnions 9 10, each of which contains an opening 11, (see Fig. 3,) surrounded at the mouth by an annular recess 12 for the reception of a suitable packing material. The recess 12 is separated from the opening 11 by a rim of metal 12^a. The retaining cap or plate 13 for each trunnion has an annular projection 14 to enter the packed recess 12 to establish an air-tight joint with said trunnion when the plate is adjusted and bolted to the main frame, as shown in Fig. 1. A cross-bar 15 is bolted to the inner end of each compression-cylinder and serves as a rod-guide to avoid any undue friction between the compressing-piston 16 and the cylinder and also assist in the movement of the latter.

The rods 17 of the compressing-pistons are provided at their inner ends with cylindrical heads 18, each pair of which is so connected with the bar 7 by yoke-plates 7^x, bolted thereto, as to permit each head to turn in its bearing and its rod to make a vibrating movement back and forth as the bar 7 reciprocates, the said heads of each pair being in contact, as illustrated in Fig. 4, so as to have a rolling motion against each other, thus serving to reduce friction. Where the heads are of strictly cylindrical form, blocks 19, adjustable through the medium of bolts 20, are employed to secure

a snug bearing for the heads and take up wear.

In the inner ends of the cylinders induction and delivery valves 21 and 22 are arranged and control communication through ports or passages extending through the trunnions, the valves 21 of each primary cylinder closing the supply through an extended passage 23, leading from the opening in the lower trunnion, while the valve 22 of each of said cylinders cuts off communication with an extended passage 24, leading to the opening in the upper trunnions, both the primary and secondary cylinders having pipe connections 25 and 26 with a receiver or reservoir 27, containing a cooling-coil.

Assuming that the piston of the engine is at the center of its stroke, the compressing-pistons are at the limit of their inward movement, as indicated by full lines in Fig. 1. The further movement of the engine-piston and slide-bar causes the pistons to be moved outward. Air is drawn in through the lower trunnions of the compression-cylinders 3 and 4, then flows along the port or passage 23 on the under side to the chambers 29 of the induction-valves through the openings controlled by the latter into the cylinders. In some cases communication may be established directly with the atmosphere through the valved end of the cylinders or through the pistons. The succeeding inward movement of the pistons in the cylinders 3 4 seats the induction-valves, compresses the air, and forces it through the openings controlled by the delivery-valves 22, after which it flows along the passage 24 to and through the upper trunnions and pipes 25 25 to the receiver, where its temperature is reduced by the cooling-coil. The air next passes from the reservoir by way of pipes 26 26 to the secondary compression-cylinders 5 6, wherein it materially assists in the completion of the stroke of the steam-piston. The return movement of the pistons in the cylinders 5 6 expels the air in a highly-compressed condition through the lower trunnions of said secondary cylinders and from which it may be conveyed to any suitable point for utilization in refrigerating apparatus or any place to be artificially cooled. It will be comprehended that the valves and passages in the cylinders 5 6 are reversed relatively to those in the cylinders 3 4. It will also be noted that the construction of the improved compressor is such that one revolution of the crank-shaft 31 suffices to cause two complete strokes of the compressing-pistons, thus compensating for their comparatively short stroke, the combined effect of the four pistons being equivalent to a double-acting direct air-compressor requiring much greater motive power.

The fly-wheel 32 and shaft 31 serve not only to regulate the stroke of the compressing-pistons, but limit the stroke of the steam-piston, while at the same time throwing the rods 17 beyond their centers.

The sliding bar 7, although of comparatively extended length and provided with large wearing-surfaces, is subjected to very little side or vertical pressure, it being properly guided by guides 32^a, having integral lugs 33, provided with bearing-plates bolted to the frame 1, as shown in Fig. 2.

From so much of the description as has thus far been furnished it will be comprehended that the energy of compression is utilized to the highest possible extent, inasmuch as the power is applied at the apex of the angle formed by the piston-rods and the slide-bar 7 and transmitted by the former in a direct line to their pistons through the changing positions of their cylinders, any loss of power experienced by one piston being compensated for by the coaction of the others. It will also be seen that as the pressure in the compression-cylinders increases the relation of each cylinder, its piston, and rod to the line of the reciprocating bar will become more nearly a right angle, so that the same power, as each pair of rods approaches alinement with each other and a position at right angles with said bar, will exert increasing compression effect, since the mutual bearing of each pair of rods at their inner ends tends to force each other outward, thus avoiding loss of energy.

Another important feature connected with this invention is the provision of having the compressing-pistons commence their outward stroke at their highest speed, which becomes gradually reduced as compression proceeds to the limit of their inward movement. By this arrangement the pistons can be adjusted to work close to the cylinder ends, thereby avoiding the usual loss of capacity from clearances. The greatest working resistance is encountered by the steam-piston in the second quarter and until it passes the center of its stroke, the second half of the piston movement being assisted by the air-pressure in the secondary cylinders, so that the steam may be cut off early and expanded to secure economy in working the engine.

The arrangement of the induction and delivery valves of each of the cylinders 3 4 is shown on an enlarged scale in Fig. 5, wherein 35 represents the interior of the cylinder at the cylinder-head; 36, the inlet-valve chamber; 37, the delivery-valve chamber. The inlet-valve 39 is of the winged form and carries the head 40, threaded to engage the cap 41, which not only serves to guide the valve, but also to adjustably limit its movements and serve as a piston to effect the closing of the valve by forming a partial vacuum as it opens. The cap 42 serves as a cylinder for inducing such closing motion. The cap 41 is introduced and adjusted through an opening in the outer casing of the valve-chamber,

which opening is closed by a cap 42, having a collar 43 engaging the threads of the casing-opening and extending within the valve-chamber to receive and permit the cap 41 to snugly move therein.

The threaded portion of the cap 41 is of greater diameter than the inner contracted mouth of the valve-opening, so that when the induction-valve leaves its seat the free edge of the threaded portion of the cap 41 will contact with the inner casing of the valve-chamber and limit the movement of the valve. By varying the threaded engagement of the cap with the head the limit of contact may be adjusted and hence the movement of the valve regulated. The delivery-valve 44 is also of the winged type, but is obviously introduced through a threaded opening in the outer casing of its chamber, said opening being closed by a cap 45, the threaded collar 46 of which extends within the chamber 37 and snugly receives and admits of the play within it of the head 47 of the delivery-valve. A small port 48 is located in the collar 46, as indicated.

When the piston moves outward in each of the compression-cylinders, the valve 39 opens, thus creating between the caps 41 and 42 a partial vacuum and at the same time permitting air to be drawn into the cylinder. When the piston ceases to draw air, the vacuum in connection with the opposition air-pressure exerted on the valve tends to quickly and positively reseat it. The delivery-valve opens as soon as the air-pressure in the cylinder exceeds that of the chamber and receiver. When the delivery-valve leaves its seat in opening, a small volume of air under pressure is admitted through the port 48 to the space between the head 47 and cap 48, the further movement of the valve cutting off said port. Now whenever pressure is removed from the inside of the cylinder the confined air between the head 47 and its closing-cap expands and causes the valve to positively and quickly resume its seat.

In order to effect the two complete strokes of the compressing-pistons heretofore referred to, it is highly important that the trunnions or bearings of each pair of opposed cylinders should be as close together as possible, while permitting mutual clearance of the inner corners of said cylinders. The relative location of the bearings indicated in Fig. 1 is sufficient to enable the rod of each compressing-piston to assume at the limit of the engine-stroke in either direction a position that will have brought the piston to its outward movement. The bar may be provided with recesses or be otherwise formed to present suitable clearance for the cylinder corners and permit their working close together.

Modifications may be made without departing from the principle or sacrificing the advantages of the invention. Parts of the invention can be used without the whole. Gears may be cut or otherwise produced on the heads of the compressing piston-rods, aiding the stout inclosing parts or housing to keep the heads in their proper working positions relatively to each other. Such arrangement is shown in Figs. 6 and 7. The heads may be eccentric or may have other form to produce a longer stroke, as shown in Fig. 8.

My compressing-cylinders, arranged as shown, may be aided by one or more compression cylinders and pistons arranged in the ordinary manner.

I claim as my invention—

1. In an air or gas compressor, the slide 7 and means for reciprocating it strongly in a right line in combination with a pair of compressing-pumps arranged on opposite sides thereof and pivotally connected thereto, arranged to oscillate on trunnions near the inner ends so as to give a motion nearly coinciding with that of the slide near each end of the stroke, all substantially as herein specified.

2. In an air or other fluid compressor, the combination with a pair of opposed compressing-cylinders and induction and delivery valves therefor said cylinders being arranged to oscillate on trunnions, at their inner ends, of a rolling connection with the inner ends of the rods of the compressing-pistons so as to turn without friction on each other, substantially as specified.

3. In an air or other compressor, the combination with a pair of opposed compressing-cylinders arranged to oscillate on trunnions located at their inner ends, of piston-rods for said cylinders having heads abutting against and arranged to roll on each other, and means for reciprocating such heads and consequently the compressing-pistons, substantially as herein specified.

4. In an air or other compressor, the combination with a supporting-frame, a pair of oscillating compressing-cylinders having diametrically-located trunnions each containing an opening 11 for the passage of the fluid, a packed recess 12 surrounding such opening and separated therefrom by a substantial rim 12^a, of a plate 13 for each trunnion bolted to the supporting-frame and having an annular projection 14, bearing in the packed recess, together with a compressing-piston and operative connections, substantially as herein specified.

5. In an air-compressor, the combination of primary and secondary balanced pairs of oscillating compressing-cylinders having suitable pistons and valves with a reservoir connecting with the delivery from one pair and with the induction of another pair by stuffing-boxes maintaining tight joints and allowing the motions, said cylinders moving in unison so that the primary pair simultaneously delivers to the reservoir, while the secondary pair similarly receives the air of compression, all substantially as herein specified.

6. In an air or other compressor, the combination with a compressor-cylinder, of its piston and actuating means, said cylinder having induction and delivery valve-chambers, located in its head and containing their respective valves, the delivery-valve chamber having a cap 45, the inner rim of which has a port 48 establishing communication between the spaces at the rear of the delivery-valve and the delivery, and adapted to be closed by the delivery-valve when unseated, so as to effect the closing motion of the valve by the subsequent expansion of the air or other gas thus received, substantially as herein specified.

In testimony that I claim the invention above set forth I affix my signature in presence of two witnesses.

JONAS CRABTREE.

Witnesses:
M. F. BOYLE,
J. B. CLAUTICE.