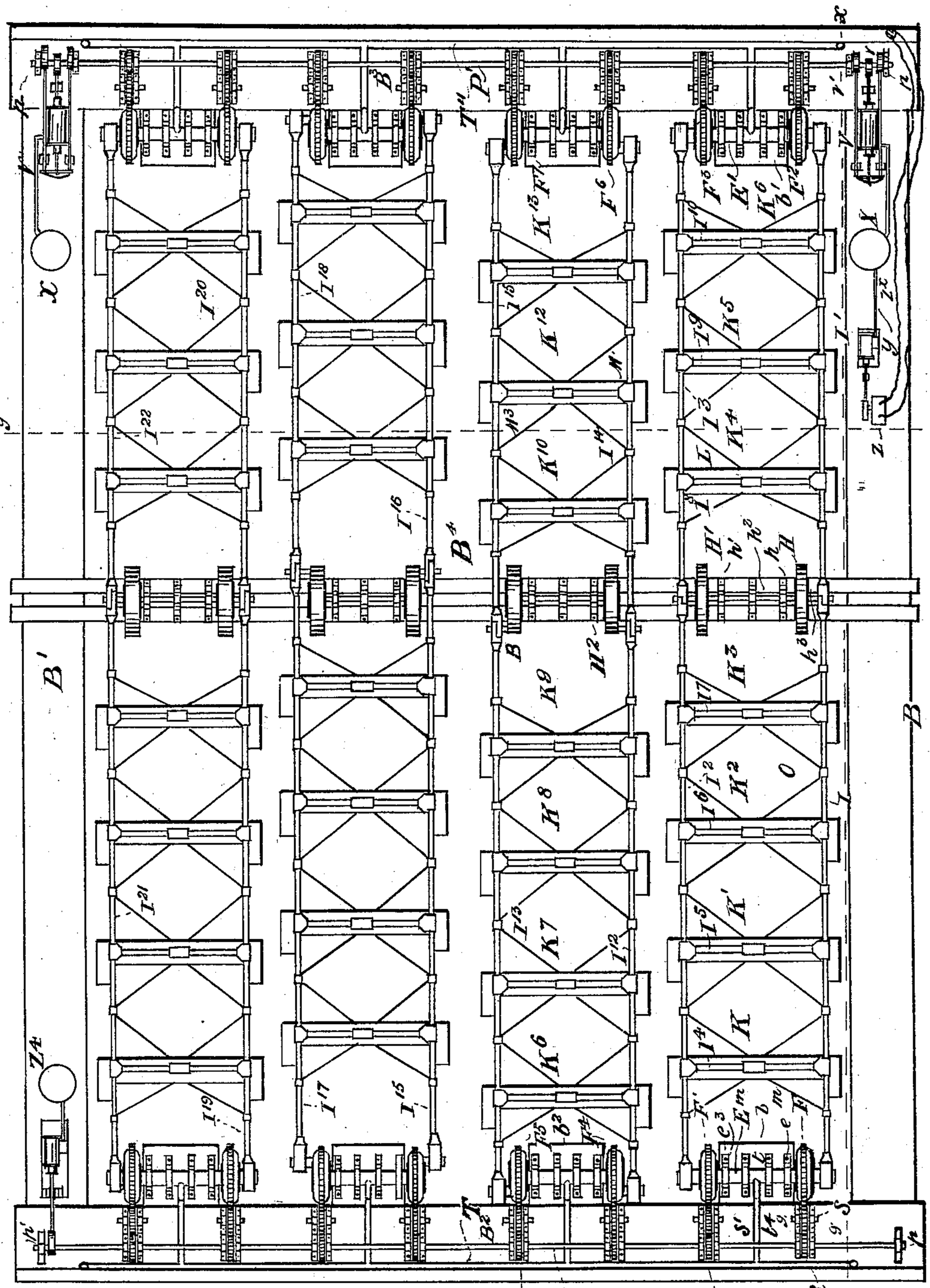
(No Model.) 3 Sheets—Sheet 1.

E. C. NICHOLS.

APPARATUS FOR COMPRESSING AIR.

No. 589,190. Patented Aug. 31, 1897.



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(No Model.) 3 Sheets—Sheet 2.

E. C. NICHOLS.

APPARATUS FOR COMPRESSING AIR.

No. 589,190. Patented Aug. 31, 1897.

Fig 3.

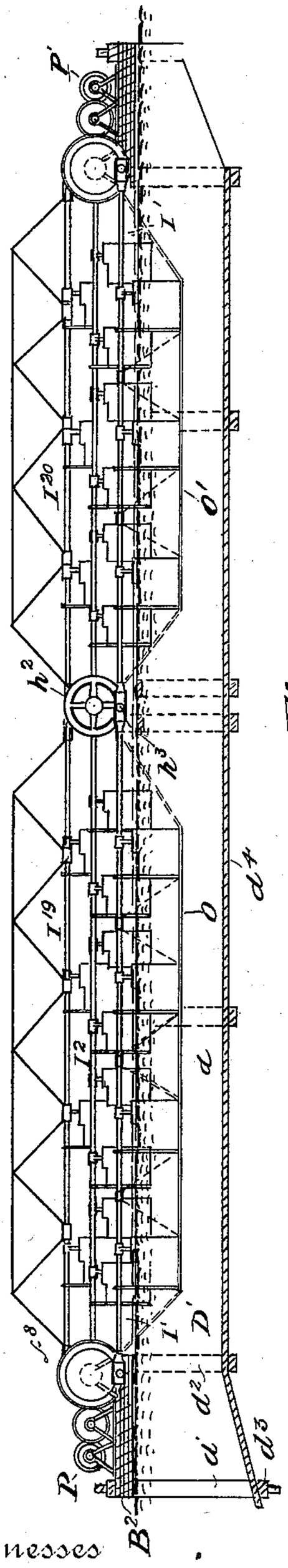


Fig 2.

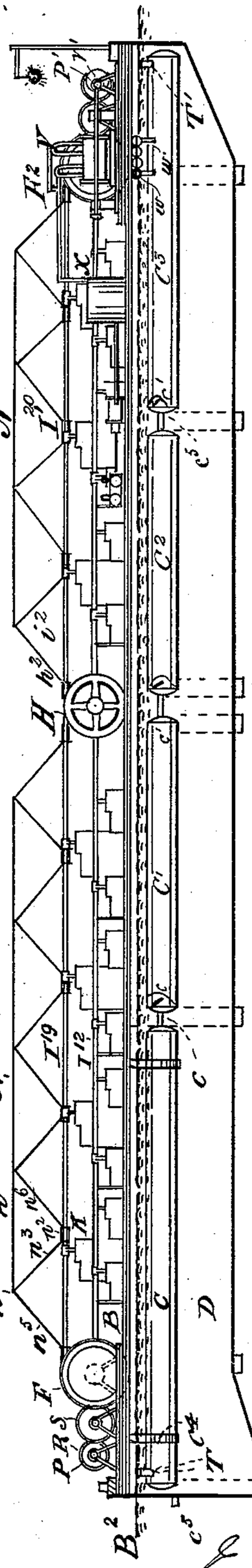
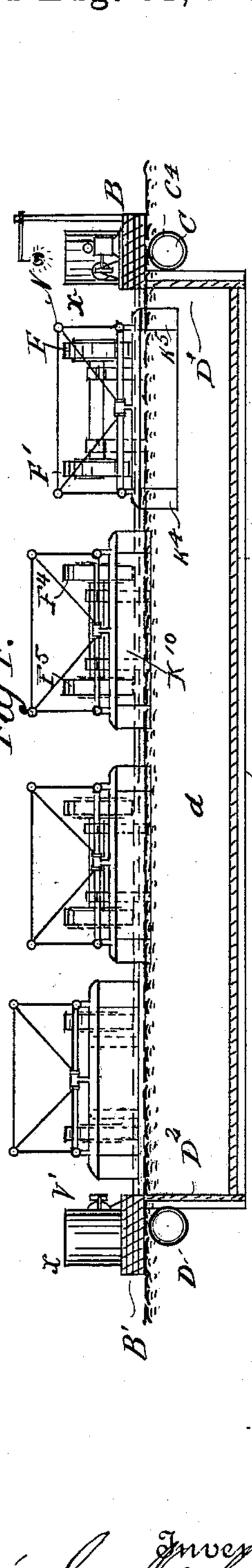


Fig 4.



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(No Model.) 3 Sheets—Sheet 3.

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APPARATUS FOR COMPRESSING AIR.

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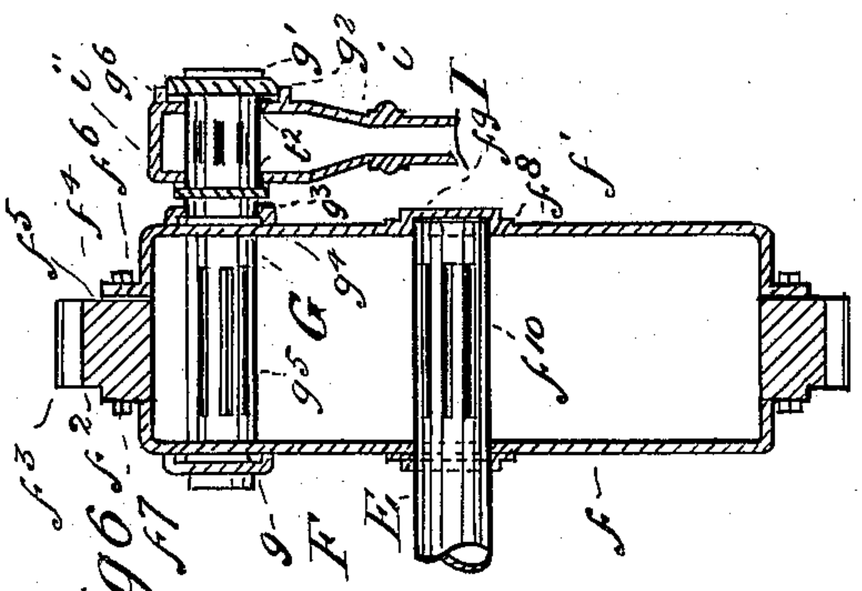

Fig 6

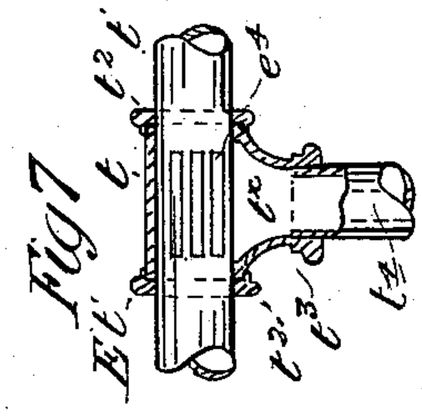

Fig 7

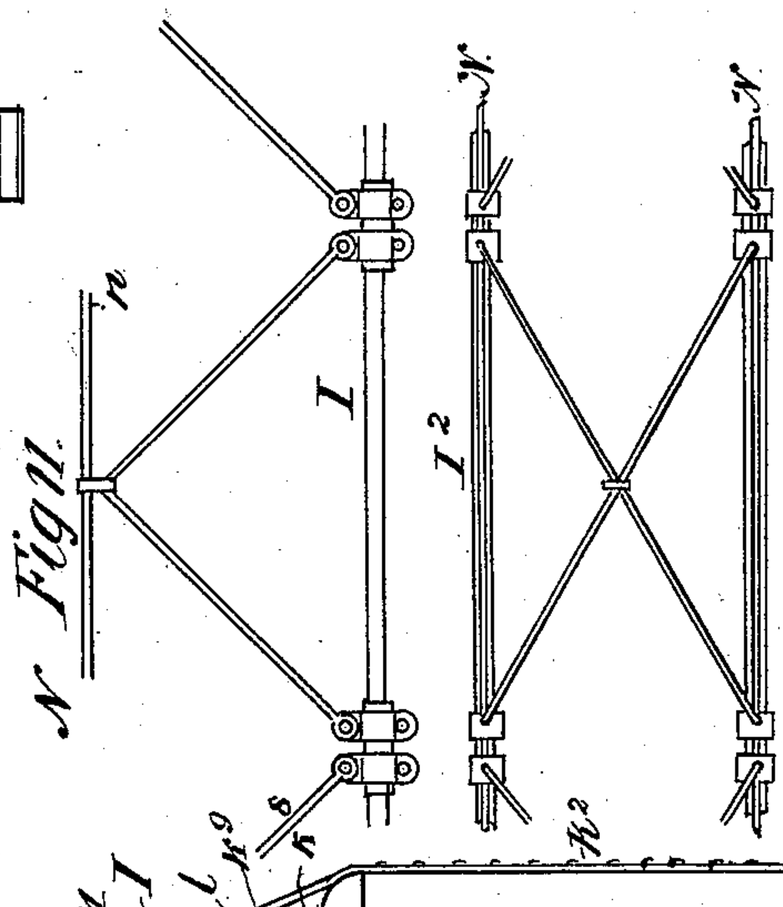

Fig 12.

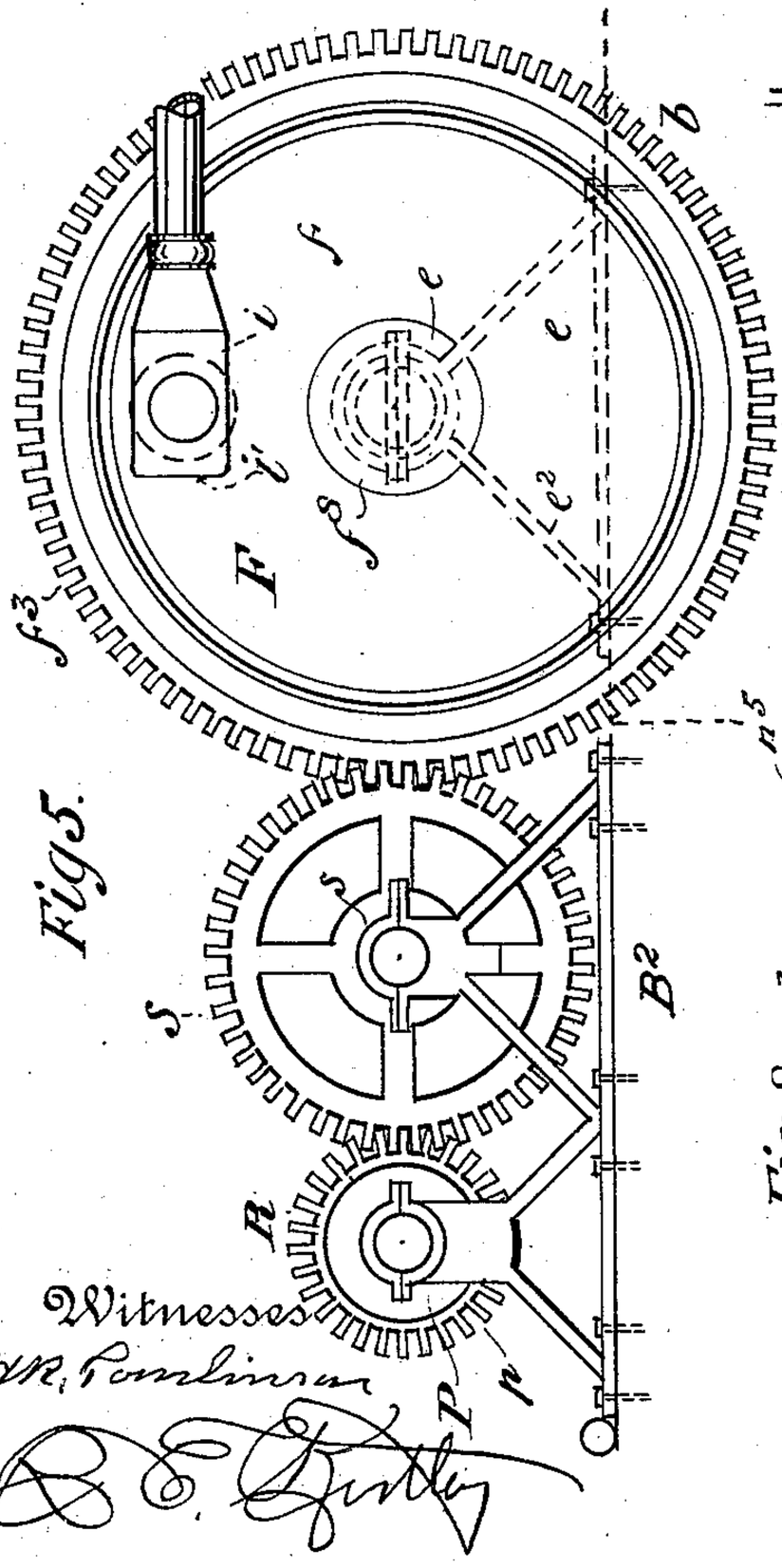

Fig 5.

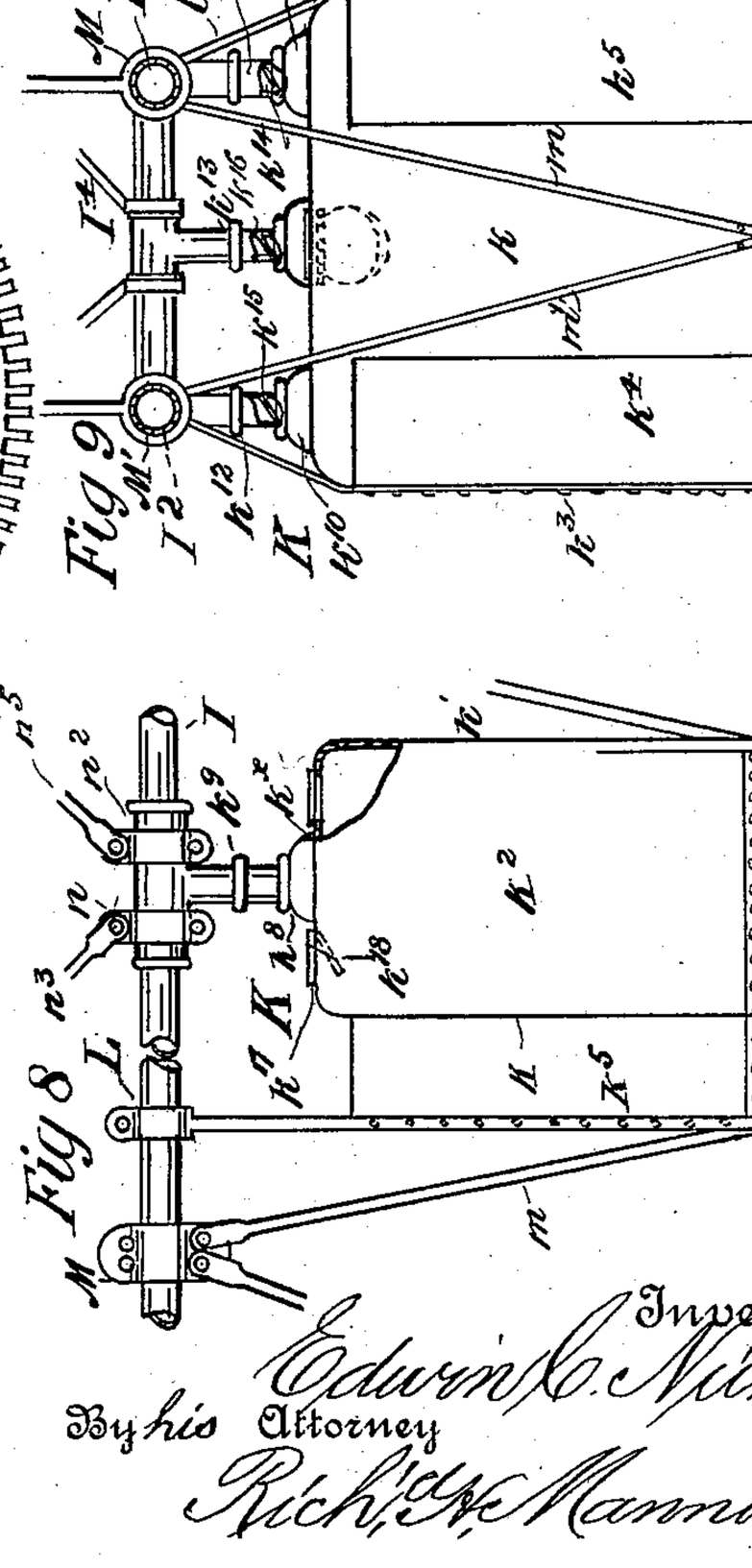

Fig 9

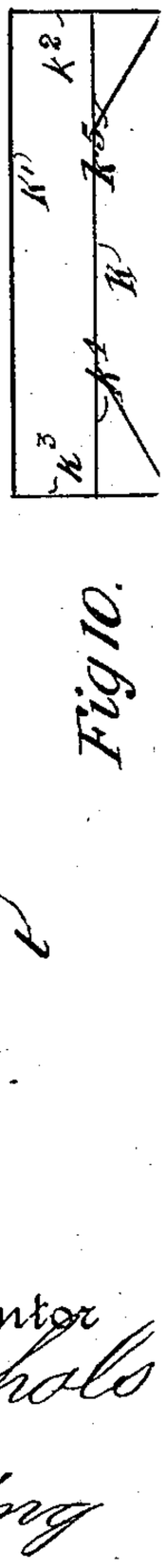

Fig 10.

Fig 8

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UNITED STATES PATENT OFFICE.

EDWIN C. NICHOLS, OF TOPEKA, KANSAS.

APPARATUS FOR COMPRESSING AIR.

SPECIFICATION forming part of Letters Patent No. 589,190, dated August 31, 1897.

Application filed August 14, 1896. Serial No. 602,810. (No model.)

To all whom it may concern:

Be it known that I, EDWIN C. NICHOLS, a citizen of the United States, residing at Topeka, in the county of Shawnee and State of Kansas, have invented certain new and useful Improvements in Apparatus for Compressing Air; and I do hereby declare that the following is a full, clear, and exact description of the invention, such as will enable others to make and use the same, reference being had to the accompanying drawings, forming a part of this specification.

My invention has for its object, first, to afford a complete expulsion of the compressed air from the one or more compartments at each compression; second, to direct the water upon the inverted air-compressing cups; third, to relieve the compressed-air-conducting pipes from back pressure; fourth, to utilize the power-transmitting wheels as expansion-chambers, and, fifth, to effect an uninterrupted pressure upon each volume of compressed air within the air-conducting pipes in series.

My invention consists in the novel construction and combination of parts, such as will first be fully described, and specifically pointed out in the claims.

In the drawings, Figure 1 is a plan view of my improved air-compressing apparatus, showing the air-compressors and storage-tank, engine, and dynamo for electric-light purposes upon the floats, with the truss-rods removed. Fig. 2 is a side view of the apparatus. Fig. 3 is a longitudinal sectional view taken upon line *x x* of Fig. 1. Fig. 4 is a cross-section on line *y y*, Fig. 1. Fig. 5 is a detail side view, enlarged, of the hollow gear-wheel and the gear connected therewith and the driving-shaft. Fig. 6 is a transverse sectional view of the hollow air-conducting wheel, showing the revoluble slotted axis, the longitudinally-slotted hollow crank-pin, and a portion of the hollow connecting-arm connected with the pin. Fig. 7 is a detail view of the hollow slotted shaft of the hollow driving gear-wheel, showing the sleeve and the compressed-air-conducting pipe connected with the sleeve. Fig. 8 is a side view of one of the inverted air-compressing cups, showing a broken portion of one of the compressed-air-conducting pipes, the branch to which the cup is attached, and the brace-rods, a portion of the top of the cup being broken away to show the relief-valves. Fig. 9 is a front view of the inverted air-compressing cup, showing the compressed-air-conducting pipes in section, a portion of the top of the cup and branch pipe being broken away to show the relief and back-pressure valves. Fig. 10 is an end view of one of the cups, looking up. Fig. 11 is a detail side view of a portion of the compressed-air-conducting pipes, showing the truss-rods. Fig. 12 is a plan view in detail of a portion of the compressed-air pipes carrying the inverted cups, showing the transverse truss-rods.

Similar letters of reference indicate corresponding parts in all the figures.

Referring to the drawings, A represents a floating carriage or barge which is suitably anchored in a stream of water, the current of which is utilized in the propulsion of the air-compressing devices. Said carriage consists of a rectangular-shaped frame, the sides of which are composed of the parallel beams B B′, arranged a considerable distance apart. The forward ends of the beams B B′ are connected together by the transverse beam B^2, which extends over the front ends of beams B B′, and the rear ends by the transverse beam B^3, which also extends over the ends of beams B B′. To the beam B, at a point a short distance toward the beam B^3, from an equidistant point between the said beam B^2 and the beam B^3, is connected one end of a beam B^4, the other end of which beam is extended to the beam B′ and connected rigidly with said beam at the same described distance from beam B^2.

Beneath beam B are separate compressed-air receivers C C′ C^2 C^3. Said receivers consist of longitudinal hollow cylinders arranged endwise is position in the water, the buoyancy of said receivers being sufficient to sustain with ease the load of the air-compressors and the requisite mechanism. To the rear end of the reservoir C is connected one end of a short tube *c*, the other end of which tube is connected with the forward end of the receiver C′. To the adjacent ends of the other receivers C′ C^2 and C^2 C^3 are connected tubes

c', which are precisely the same as the tube c and permit the free expansion of the air and its passage to the receiver C^3.

The receiver C is connected at its forward end with the beam B by means of the strap or loop c^4, which strap is connected at one end by the under side portion of the beam B near its other edge, and thence extended beneath said receiver, and the other end connected with said beam at a point between the outer and inner edges. The other end of the receiver is connected with the beam B in the same manner as described of the forward end, and each receiver in the series is also connected in like manner. The receiver C, which supports the front end of the beam B, is nearly twice the length of the receiver C^3, which receives the supply of compressed air from the other receivers. In receiver C^3 is a valve C^5.

Upon the other side of the frame and beneath beam B′ are separate compressed-air receivers D, which are constructed and arranged in position in precisely the same manner as the respective receivers C C′ C^2 C^3. To the forward end of beam B, in line with the inner edge of the said beam, is attached the upper end portion of a wall D′, which extends the entire length of and to the rear end of said beam and a considerable distance in a downward direction. Upon the other side of the carriage and beneath the beam B′ is a wall D^2, between which walls is formed a sluice d. (See Fig. 4.)

Upon the inner side of the walls D^2, at the forward end of the carriage, are vertical stays d' d^2, the stay d' being attached to the extreme outer end of the said wall and the stay d^2 a short distance therefrom in the direction of the other end of the carriage. The lower ends of the stays d^2 extend in a downward direction an equal distance to that described of the walls D D′. The stays d' extend at their lower ends a short distance below the line of the lower ends of the respective stays d^2. To the lower end of the stay-bar d, on the side D^2, is connected one end of a bar d^3, the other end of which bar is connected with the lower end of the bar d' on the side D′. To the inner side and lower end portion of the wall D′ is connected the floor or bottom d^4 of the sluice, which extends to the lower end of the wall D′ and from the rear end of the respective walls to the stays d^2 in a horizontal line of direction. From said stays d^2 to the transverse bar d^3 a portion of the bottom is inclined downwardly at an angle to the horizontal portion d^4, thus retarding the flow of the water along the bottom d^4 of the sluice and accelerating the speed of the upper currents of water.

The bottom d^4 may be dispensed with under conditions favorable to rapid movement of the water. At the forward end of the carriage A and upon the end of beam B^2, at a point a short distance from the beam B, is a journal-bearing e, which is supported by a rear jog or extension b of said beam, of sufficient width to give a clearance on each side for the hollow power-transmitting wheels. Upon said jog b are upwardly-extended braces or legs e' e^2, secured to the jog b on the side opposite beam B, and to which the bearings are attached.

In the direction of the beam B′ on the jog b the proper distance from the journal-bearing e is a journal-bearing e^3, which is supported the same height as the journal e. In the box e is journaled one end of a hollow shaft E, the other end of which shaft is journaled in the box e^3. Both ends of shaft E are closed, and upon said shaft near the journal-box e is mounted a hollow gear-wheel F, which is constructed as follows:

Two circular plates f f' are shrunk on the shaft E at a considerable distance from each other. At the periphery of the plate f a portion is bent at right angles and extended in the direction of the plate f' a short distance and connected rigidly with the side of an annular casting or ring f^2. Upon the outer surface of ring f^2 and extending around said ring are gear-pitched teeth f^3. The peripheral portion of the plate f' is also bent at right angles and extended in the direction of the ring f^2 and to within a slight distance of said ring, and thence bent at right angles and extended in an upward direction nearly to the teeth f^3, forming an annular flange f^4. Between the flange f^4 and the side portion of ring f^2 is an annular packing f^5. Through the annular flange f^4 and the ring f^2 is inserted a threaded bolt f^6, upon which is a nut f^7. Other screw-threaded bolts are inserted through the flange f^4 and the ring f^2 at suitable distances from each other and around the wheels, so as to prevent the escape of the compressed air.

The inner end portion of the shaft E is extended within an annular depression f^8 on the inner side of the plate f' in a direct line with the said shaft. The shaft E is provided with a flanged collar e^8, which is fitted against the outer side portion of the plate f, suitable packing being interposed between the collar and plate.

In shaft E, between the respective plates f f', are the longitudinal slots or openings f^{10}, a number being made at regular distances in the circumference of the shaft. Through the respective plates f f', at a point a short distance from the periphery of wheel F, is inserted a hollow wrist-pin G. Said pin consists of a tube of nearly the same diameter as shaft E, one end extending a short distance beyond the outside portion of the plate f and externally screw-threaded, upon which end is fitted an internally-threaded cap g. The other end of the tube extends a considerable distance beyond the outside portion of the plate f' and at its extreme outer end is externally screw-threaded and provided with an internal screw-threaded cap g'. Said cap g' is also provided with a screw g^2, extending in

the direction of tube G and against the surface of said tube, so as to prevent accidental turning of the cap g'. On tube G and the end having the cap g' and bearing against the plate f' of the wheel is a flanged collar g^3, which is made integral with the tube G, and between the flanged portion of the collar and plate f' is a packing g^4, so that when the cap g is made tight the tube G is rigid with the plates $f\,f'$, and the packing prevents any leakage of compressed air.

In the wrist-pin G, between the respective plates $f\,f'$, are longitudinal openings or perforations g^5, a suitable number being made at equal distances apart in the surface of the pin. In the end portion of the pin having the cap g' and between said cap and the plate f' are longitudinal openings g^6 short in length, for the purpose hereinafter specified.

Upon the other side of shaft E, outside of the journal-box e^3, at one side of jog b, in sluice d, is a hollow power-wheel F', which is constructed in precisely the same manner and is of the same dimensions as the wheel F, the extension of the wrist-pin being from an opposite side to that in wheel F. In the hollow shaft E, between the wheels F F', are longitudinal slots e^4 for the purpose hereinafter described.

Upon the end beam B^3 of the water-carriage A, near beam B and in line with the wheel F, is mounted on a jog b', in elevated journal-boxes of the same height as the journal-boxes $e\,e^3$, a hollow power-transmitting wheel F^2, which is constructed and mounted in position upon its shaft E' in precisely the same manner as the wheel F, said shaft E' being arranged in a parallel position with and corresponding in length to the shaft E. At the other end of shaft E is mounted a hollow power-transmitting wheel F^3, which is precisely the same as the wheel F'.

Upon the cross-beam B^4 of the water-carriage, the same described distance from the beam B as the shaft E and parallel with said shaft, is mounted in the journal-boxes $h\,h'$ a solid shaft h^2, said shaft being of the same length as the shaft E and arranged in position the same height above the frame of the carriage. Upon one end of shaft h^2, in line with the respective wheels F F^2, is mounted an ordinary spoked wheel H, which is nearly of the same circumference as that of wheel F. Upon the other end of shaft h^2 is mounted a spoked wheel H', which is the same in circumference as wheel H.

To the wrist-pin G on the hollow wheel F is attached loosely and in the following manner one end i of a horizontal connecting pipe or tube I. Said end i is flattened upon both sides and extended in width a considerable extent and upon its extreme outer end closed or capped at i'. In the sides of the flattened end portion of pipe I is an opening i^2, which is nearly of the same circumference as the slotted portion g^6 of the wrist-pin G. The cap g' being first removed from the wrist-pin the flattened end of the pipe I is fitted to the wrist-pin and the cap replaced, the packing in the cap g' preventing any leakage of compressed air from the tube. The other end i^2 of pipe I is closed, the inner side of said end being brought together and welded. On the outer side portion of the wheel H is a solid wrist-pin h^3. In the flattened end portion i^2 of the pipe I is a circular opening which receives loosely the wrist-pin h^3 of wheel H. In connecting the pipe I with the wrist-pin G on wheel F and with the wrist-pin h^3 on wheel H both wrist-pins are placed at the highest point of elevation in the rotation of each wheel, the pipe I being of the precise length to connect with each pin, the end i^2 being retained upon the wrist-pin h^3 in the ordinary manner.

To the wrist-pin on the hollow wheel F^2 is connected one end of a horizontal pipe I', which end is constructed precisely the same as the end i of the pipe I and is connected with the wrist-pin upon said wheel in like manner, the position of said pin when the pipe is attached being also elevated at its highest point. The other end of pipe I is flat and the parts welded together in the manner described of the end i^2 of the pipe I and also provided with a circular opening for the wrist-pin h^3 on the wheel H and is fitted to said wrist-pin and close in position to the end i^2 of the pipe I.

To the wrist-pin on the hollow wheel F' is connected one end of a horizontal pipe I^2, which is constructed in precisely the same manner as described of pipe I, the other end of said pipe I^2 being connected with the wrist-pin on the spoked wheel H'. To the wrist-pin on the hollow wheel F^3 is connected one end of a horizontal pipe I^3, which is connected precisely the same as the pipe I' and the other end connected with the spoked wheel H' on the wrist-pin to which the pipe I^2 is connected and in like manner.

To the pipe I, a short distance in rear of the wheel F, is connected by a suitable T connection one end of a cup-supporting pipe I^4, the other end of which pipe extends at right angles to pipe I and is connected with the pipe I^2. A short distance beneath pipe I^4 and connected therewith as hereinafter described is an inverted air-compressing cup K. Said cup is rectangular in shape and consists of the respective front and back plates or sides $k\,k'$ and ends $k^2\,k^3$ and top $k^\times$. The end k^2 is extended beyond the front side k a considerable distance and thence bent at an angle to the said end k^2 in the direction of the front plate k and connected rigidly with said plate, forming a triangular projection or wing k^4. The other end k^3 is also extended in the same manner as the end k^2 and thence in the direction of plate k, and a triangular wing k^5 formed, which acts to retard the water. The top portions of these wings are open, so as to not compress air.

The top $k^\times$ is nearly horizontal and with the sides $k\,k'$ and wings $k^4\,k^5$ extends outwardly

in opposite directions beyond a vertical line drawn through the respective pipes I I^2.

In the top $k^\times$ and near one end k^2 is a circular outward depression or dome k^8, to which is connected a branch pipe k^9, which is connected at its upper end by a T-coupling to the under side portion of the pipe I. Near the other end k^3 of the inverted cup K is a dome k^{10}, to which is attached a branch pipe k^{12}, which is attached at its upper end to the under side portion of the pipe I^2. To the under side portion of the cross-tube I^4 is connected a branch pipe k^{13}, which extends downwardly and is connected with the top $k^\times$ at a point equidistant from the domes k^8 k^{10}. In the upper part of the dome at the entrance to tube k^9 is a check-valve k^{14}. In the upper part of the dome k^{10} and at the entrance to pipe k^{12} is a check-valve k^{15}. In the pipe k^{13} is a check-valve k^{16}. In the top $k^\times$ on one side of tube k^{13} is an opening k^{17}, which is closed by a valve k^{18}, hinged to the inner side portion of the top $k^\times$. Upon the other side of the pipe k^{13} is a similar valvular opening to k^{17}. On the side k^2, near the lower edge portion, is riveted a flat bar l, which extends to the forward edge of the wing k^5 and is then bent at right angles and extended edgewise in an upward direction along the edge of the wing and secured firmly to a collar L on the tube I. Upon the side k^3 is a bar attached to the cup and pipe I', as described of bar l.

On the respective pipes I I', a short distance from the collar L, toward the wheels F F', are collars M M'. To the collar M is attached one end of a bar m, the other end of which extends to the lower edge of the front side k of cup K at a point equidistant from wings k^4 k^5 and is turned edgewise in position. To the collar M' is attached one end of a bar m', the other end of which bar extends downwardly and is attached to front plate k near the lower edge and at the point described of bar m. To the back plate k', near the lower edge and at a point equidistant from the ends of said cup K, are attached brace-rods, which are precisely the same as the rods m m' and are connected with the respective pipes I I' in like manner. It will thus be seen that the inverted cup K is held rigidly in position and securely from forward or lateral movement on the respective tubes.

A short distance in rear of the inverted cup K is an inverted cup K', and in rear of the cup K' are the respective cups K^2 K^3 in series, which are supported by the longitudinal pipes I I' and transverse tubes I^5 I^6 I^7 and constructed and arranged in position in the pipes I I' in precisely the same manner as described of the inverted cup K, the said cups being arranged at equal distances apart one from another.

Upon the longitudinal pipes I' I^3 and the transverse tubes I^8 I^9 I^{10} are the respective inverted cups K^4 k^5 k^6, which are constructed and arranged in position in precisely the same manner as the respective cups K K' K^2 K^3 and at the same distance apart, all of said inverted cups extending within the sluice d their greatest depth in each full rotation of the power-transmitting wheels.

Adjacent to the series of air-compressing cups K, K', K^2, K^3, K^4, K^5, and K^6 and parallel therewith in sluice d are inverted air-compressing cups K^6 K^7 K^9 K^{10} K^{12} K^{13}, which are constructed precisely the same as the cup K and arranged in position upon horizontal pipes I^{12} I^{13} I^{14} I^{15} in like manner, said horizontal pipes being connected with power-transmitting hollow wheels F^4 F^5 F^6 F^7 arranged in position on the respective beams B^2 B^3 in the same manner as described of the hollow wheels F F' F^2 F^3, and with the intermediate spoked wheels H^2 H^3, as described of wheels H H'.

For the purpose of sustaining the accumulated weight of the series of inverted air-compressing cups and also give rigidity to the respective tubes I I' I^2 I^3 a truss-frame N is connected with the longitudinal tube I^{19} in the following manner: At a suitable height above the tube I is arranged parallel with said tube a rod or bar n. On the tube I, at a point close in position to the tube k^9, connected with the cup K, and on the side of said tube toward the wheel F, is a collar n'. Upon the other side of said tube is a collar n^2. To the collar n' is connected one end of a rod n^3, the other end of which rod extends upwardly and forwardly at an angle to the tube I and is connected with a fixed collar n^4 on the rod N. To the collar n^4 is connected one end of a rod n^5, the other end of which is connected rigidly with the end portion of the pipe I near the point of connection with the wheel F. To the collar n^2 is connected one end of a rod n^6, the other end of which collar is extended in an upward direction and rearwardly at an angle to the pipe I and connected with a fixed collar on the rod n, to which collar is connected a rod extending in a downward direction and connected with a collar in the pipe I near the branch pipe to the cup K'.

A series of braces are connected in like manner with the respective pipe I and rod n in precisely the same manner as described of the braces n^3, n^5, and n^6, said rod n being shorter in length than the pipe I and trussed its entire length with the pipe I. The pipe I^{20} is also provided with a trussed support N', which is precisely the same in construction as the trussed support N, and the respective pipes I^2 I^3 are each provided with trussed supports which are the same in construction as the trussed support N. In the respective series of tubes each pipe is provided with a trussed support, as described of the trussed supports N N'.

Beneath the inverted compression-cups and attached at one end to the lower edge portion of the plate k' of the cup K is a longitudinal bar O, which bar extends beneath each one of the respective cups K K' K^2 K^3 K^4

K^5 and serves to bind one cup with another in the series of air-compressing cups. Other bars O', of the same description as bar O, are employed in each series of cups.

Adjacent to the heretofore-described series of inverted air-compressing cups and supported in position and in communication with the said cups are parallel pipes I^{15} I^{16} I^{17} I^{18}, supporting one series of cups, and the parallel pipes I^{19} I^{20} I^{21} I^{22}, supporting another series of inverted cups, thus making four separate series of cups connected as described of the preceding series, one of each series entering the water in sluice *d* at each quarter of the circle of rotation of the power-transmitting wheels, geared as hereinafter described.

Upon the beam B^2 and extending its entire length and also transversely to beams B B' is a line-shaft P, which is arranged in rear of the outer edge of the said beam B^2 and supported in journal-boxes *p p'* on the transverse beam B^2 at each end, which journal-boxes are raised the described height of the journal-boxes *e* e^3, supporting the shaft E and wheels F F'. Said shaft is also supported at suitable points on beam B^2 between the journal-boxes *p p'*.

Upon the shaft P opposite the hollow wheel F is a small gear R. On the same shaft and opposite the hollow wheel F' is a small gear R'. Opposite the wheels F^4 F^5, transmitting power from the adjacent series of cups, are small gear R^2 R^3, respectively, and opposite each remaining hollow wheel in each series of inverted cups are gear corresponding to the gear R. Between the small gear R and the hollow gear-wheel F and journaled in elevated journal-boxes *s s* is a gear S, which is twice the circumference of gear R and meshes with said gear and the gear on the hollow wheel F. Between the gear R' and the wheel F' is a gear S', which meshes with the said gear, and between each small gear on the same shaft opposite each one of the hollow wheels is a gear of the same circumference and meshing with the small and hollow gear, as described, of the gear S and wheel F.

For the purpose of enabling the separate inverted cups in series to enter and be drawn from the water at different times the wheel F is geared with the gear S and the small wheel on the line-shaft with the crank-wrist on the wheel F at its lowest point of depression. The adjacent hollow and spoked wheels F^4 F^5 F^6 F^7 and H^2 H^3, respectively, are geared with the small wheel on the line-shaft P and the intermediate gear in such a manner that the inverted cups operated by said wheels are drawn about half of their length from the water or raised in position so as to bring the horizontal pipes I^{12} I^{13} and I^{14} I^{15} in line with the axis of the spoked wheels H^2 H^3. The wheels carrying the succeeding series of inverted cups are so placed in position that each crank-wrist is at the highest point of elevation or one-half way round the circle, and the wheels in the next series of inverted cups so placed as to carry the wrist-pin three-quarters way round in the direction of the circle.

On the shaft E, carrying the respective hollow wheels F F' and slotted at *e*, is a stationary sleeve *t*, having externally-smooth ends and an external smooth collar *t'* at each end fitting snugly the outer surface of shaft E and over the slots *e* in said shaft. Between each collar *t'* and the end of the sleeve *t* is packing t^2. In the side of sleeve *t* is an opening $t^\times$. To sleeve *t*, around the opening $t^\times$, is a neck t^3.

To the upper side portion of the compressed-air receiver C beneath beam B is connected one end of a pipe T, which pipe extends upward through the forward end of beam B^2, thence in a transverse direction to the apparatus, over the upper part of sluice *d*, and the other end connected with the upper portion of the receiver D, passing downwardly through the other end of the beam B^2.

On the shaft supporting the wheels F^4 F^5, which is also slotted, as described of the shaft E, is a sleeve connection, and also upon each shaft in the series of shafts corresponding to shaft E, which is the same as sleeve *t*. To the sleeve on shaft E and neck t^3 is connected a branch pipe t^4, which pipe is connected with the transverse pipe T, and from the other connections are connected branch pipes, all of which connect with the pipe T.

On the beam B^3 and near the outer edge portion of said beam is a line-shaft P', which is parallel with and mounted in journal-boxes in the same manner as shaft P on beam B^2. Upon the line-shaft P' are small gear of the same circumference as the gear R on shaft P, and intermediate gear are meshed with the small gear and the hollow wheels, as described, gear S.

To the upper rear end portion of the receiver C^2 is connected one end of a compressed-air-conducting pipe T', the said end passing upward through the rear end of the beam B and transversely to the rear end of the receiver D at the rear end of beam B'. With said pipe T' is connected all of the tubes connected with the respective shafts, as described of shaft E.

Upon the rear end portion of the beam B is a duplex air-compressor V, the pistons of which are actuated by eccentrics *v' v' v'* on the end portion of the rear line-shaft P'. Upon the rear end of the beam B' is a duplex air-compressor V', which is also actuated by eccentrics on the line-shaft P'.

A short distance above the water-line and from the side of the receiver C^3 is an upwardly-extended bent pipe *w*, which is directly connected with the induction-opening of one of the duplex air-compressors V.

Near the pipe *w* and extending upwardly from the side of receiver C^3 is a pipe *w'*, which is connected with the eduction-opening of the duplex air-compressor.

The air-compressor V' is provided with

pipes connected with the induction and eduction openings and also with the receiver D at the rear end of the apparatus in the same manner as the compressor V.

Upon the beam B is a storage-tank X. With said tank is connected the eduction-pipes extending from the air-compressor V. Upon the beam B′ is a storage-tank X′, with which is connected the eduction-pipes from the air-compressor V′.

Y is an air-engine on the beam B, and *y* is a pipe connected with the storage-tank X and the air-engine.

Z is a dynamo on the surface of beam B, and *z* is the belt connection from the engine to the dynamo.

x′ represents the electric-light pole on the end of the carriage, and $Z^{\times}$ $Z^{\times}$ the wires, connected with the dynamo and the lamps on the pole *x′*.

Z^2 is an engine on the beam B′, the engine being connected with the line-shaft P, so as to operate the cups when the currents of water are sluggish.

In operation the apparatus is anchored in a stream, with the forward end of the carriage abreast of the current, the water entering the sluice *d*, and being retarded in its flow upon the inclined entrance and the bottom to the sluice a rapid movement of the current is effected, which striking the forward portion or plate *k* of the series of inverted air-compressing cups, which are in a position to receive the energizing force of the currents and are moved a short distance rearwardly, the lower ends describing the arc of a circle, and this power of the water being directly between the wings of the respective cups is fully utilized, the separate series of cups within the sluice at the first application of the motive power of the water causing a rotation of the power-transmitting wheels and the entry of the separate series of cups in the water in succession. In the movement of the air-compressing cups in one series and connected, for instance, with the respective conductors of compressed air I I' I^2 I^3 the air enters the cups during withdrawal from the water, and upon describing the forward movement and during the time the crank-wrist upon the wheels F F' F^2 F^3 is describing one-quarter of the circle of rotation the open ends of the inverted cups enter the water. In this movement the confined air in the cup K closes the valves k^{18}, and the cup enters the sluice *d* its full length and compresses the air within the cup. The water consequently meets the inner surface of the cup and the upward pulsations of the water combined with the downward movement of the cups forces the volume of compressed air in its entirety from the cups into the air-conducting tubes I I^2, the valves k^{15} k^{16} k^{17} being lifted by the compressed air. As soon as the volume of air is expelled from the cup the cup describes a rearward and upward movement, the valves k^{15} k^{16} k^{17} immediately close, checking the return of the compressed air, and the valves k^{18} open and relieve the tendency to create a vacuum in withdrawal from the water. The result of the compression is the same in each cup, the compressed air passing with renewed impetus through the tubes I I' I^2 I^3, thence through the slotted wrist-pin g^6 into the hollow wheels F F' F^2 F^3, in which an initial expansion takes place, thence through the slots f^{10} in the shaft E and through the tube t^4 into the transverse pipes T T′, and thence into each receiver C D on opposite sides and forward ends of the apparatus, and thence through the respective receivers C' C^2 into the receiver C^3 upon one side of the apparatus and into the similar receivers at the rear end and upon the other side, the compressed air being then supplied through the pipes *w*, *w′*, and v^8 in a large quantity, the air-compressors V V′ taking the compressed air under initial compression, and after full compression the air passes into the storage-tanks X X, and is then supplied to the air-engines Y, which utilize the highly-compressed air-conveying motor-power to the dynamo Z for the generation of electricity for lighting purposes or any other purpose to which an economical method of generating compressed air can be applied.

In the regular sequence in which it is observed the separate series of compressed-air cups enters the water in sluice *d* no intermission takes place in the flow of compressed air through the pipes I I' I^2 I^3, and as the speed of the wheels F F' F^2 F^3 increases a continuous energizing volume of compressed air is obtained. In passing through the openings to the pipes v^8 and *w* from receiver C^3 the air-compressors draw upon the initial compressed air in the receivers C C′ and are compressed. The air-wheel passes to the tank X through the induction-pipes, the compressed air being utilized in the direction preferred.

The capacity of the hollow wheels to which the air-conducting tubes are attached is such as to relieve the overcharged tubes, and the compressed air is afforded a primary receiver while the larger quantity from all the sources is passing through the compressed-air pipes T T′ into the receivers C and D.

The capacity of the apparatus may be increased in width and length and a separate sluice from sluice *d* employed in which separate series of air-compressing cups may be employed, constructed, and arranged as heretofore described and connected with the water-carriage A, thereby affording opportunity for suspension in operation of one series of air-compressing cups when desired for renewal or repair of the operating parts.

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

1. In a compressed-air apparatus, a conductor for compressed air comprising a hollow wheel, having a hollow perforate crank-wrist, a hollow shaft having openings within the

wheel, and a compressed-air conductor connected with said crank-wrist, as and for the purpose described.

2. In a compressed-air apparatus a receiver for compressed air and a sluice, a hollow compressed-air-conveying wheel at each end of said sluice having its axis provided with openings extending within said wheel, and a perforate crank-wrist, horizontal air-conducting pipes having closed ends journaled upon said crank-wrists and connecting the wheels at opposite ends of said sluice, a conductor of compressed air connected with the axis of said wheels and said receiver, and a water-energized air-compressor within said sluice having an eduction-pipe connected with said horizontal air-conducting pipes on said wheels, and suitable check-valves, substantially as shown and described.

3. In a compressed-air apparatus the combination of a receiver for compressed air and a sluice, hollow compressed-air-conveying wheels at each end of said sluice, each wheel having its axis provided with openings extending within said wheel, and a perforate crank wrist-pin, horizontal air-conducting pipes having closed ends journaled upon said crank wrist-pin and connecting the wheels at opposite ends of the sluice, a conductor of compressed air connected with the axis of each of said wheels and said receivers, and water-energized inverted cups in said sluice having branch pipes connected with the horizontal air-conducting pipes on said wheels and check-valves for checking the backflow of compressed air, and a relief-valve for the admission of the external air, substantially as shown and described.

4. In a compressed-air apparatus the combination of a receiver for the compressed air, and a sluice, and a hollow compressed-air-conveying wheel at each end of said sluice having a hollow perforated shaft closed at both ends, and openings in said shaft within said hollow wheel, and a hollow perforate crank wrist-pin having a removable cap, horizontal air-conducting pipes having closed ends, journaled at said ends upon said crank-pins, and connecting the wheels at each end of said sluice, water-energized air-compressors within said sluice having a pipe connected with said horizontal air-conducting pipes, and a loose sleeve on said shaft having a packed collar at each end, and a conductor of compressed air connected with said sleeve and said receiver, substantially as and for the purpose described.

5. In a compressed-air apparatus a receiver for the compressed air and a sluice, a series of water-actuated inverted air-compressing cups, a hollow compressed-air-conveying wheel having crank-pins at each end of said sluice and compressed-air-conducting pipes journaled upon said crank-pins, and a hollow wheel having a hollow perforate shaft, a conductor of compressed air connected with said shaft and said receiver, and a conductor of compressed air connected with the said conducting-pipes on said wheels and said shaft, substantially as shown and described.

6. In a compressed-air apparatus a water-actuated inverted cup, having forward extensions or wings, substantially as shown and described.

7. In a compressed-air apparatus a water-actuated inverted cup and forward extensions of said cup having inwardly-inclined sides, substantially as and for the purpose described.

8. In a compressed-air apparatus the combination of receivers for the compressed air, and a frame supported by said receivers, a sluice, a transverse line-shaft journaled upon the forward end portion of said frame, a hollow compressed-air-conveying wheel at each end of said sluice each having a crank-pin, and a hollow perforate shaft each shaft being journaled on the sides of the sluice within the lines of the transverse line-shaft and parallel therewith, horizontal air-conducting pipes journaled at each end upon the crank-pins of the said wheels at respective opposite ends of the sluice, a series of inverted air-compressing cups within said sluice having valvular branch pipes connected with the horizontal air-conducting pipes, a conductor of compressed air connected with the latter pipes and said receiver and meshing gear on said line-shaft and each separate shaft having the power-wheels, as and for the purpose described.

9. In a compressed-air apparatus the combination of receivers for compressed air and a sluice between said receivers, and a compressed-air pipe connected with the separate receivers, hollow wheels at each end of said sluice, each hollow wheel having a perforate tubular crank wrist-pin and a hollow revoluble shaft closed at both ends and having an opening for the compressed air within the hollow wheel and also externally thereto, a loose sleeve upon said shaft, and a conductor of compressed air connected with said sleeve and also with the pipe connected with the receivers, and horizontal compressed-air-conducting pipes closed at both ends and journaled upon the cranked wrist-pins, upon wheels at respective opposite ends of the sluice, inverted air-compressing cups in said sluice, and branch pipes connected with the horizontal pipes and also with the top portion of said cups, and a valve for checking the backflow of compressed air, and a separate valve for admitting the external air, substantially as described.

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Witnesses:
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PAUL HUDSON.