(No Model)

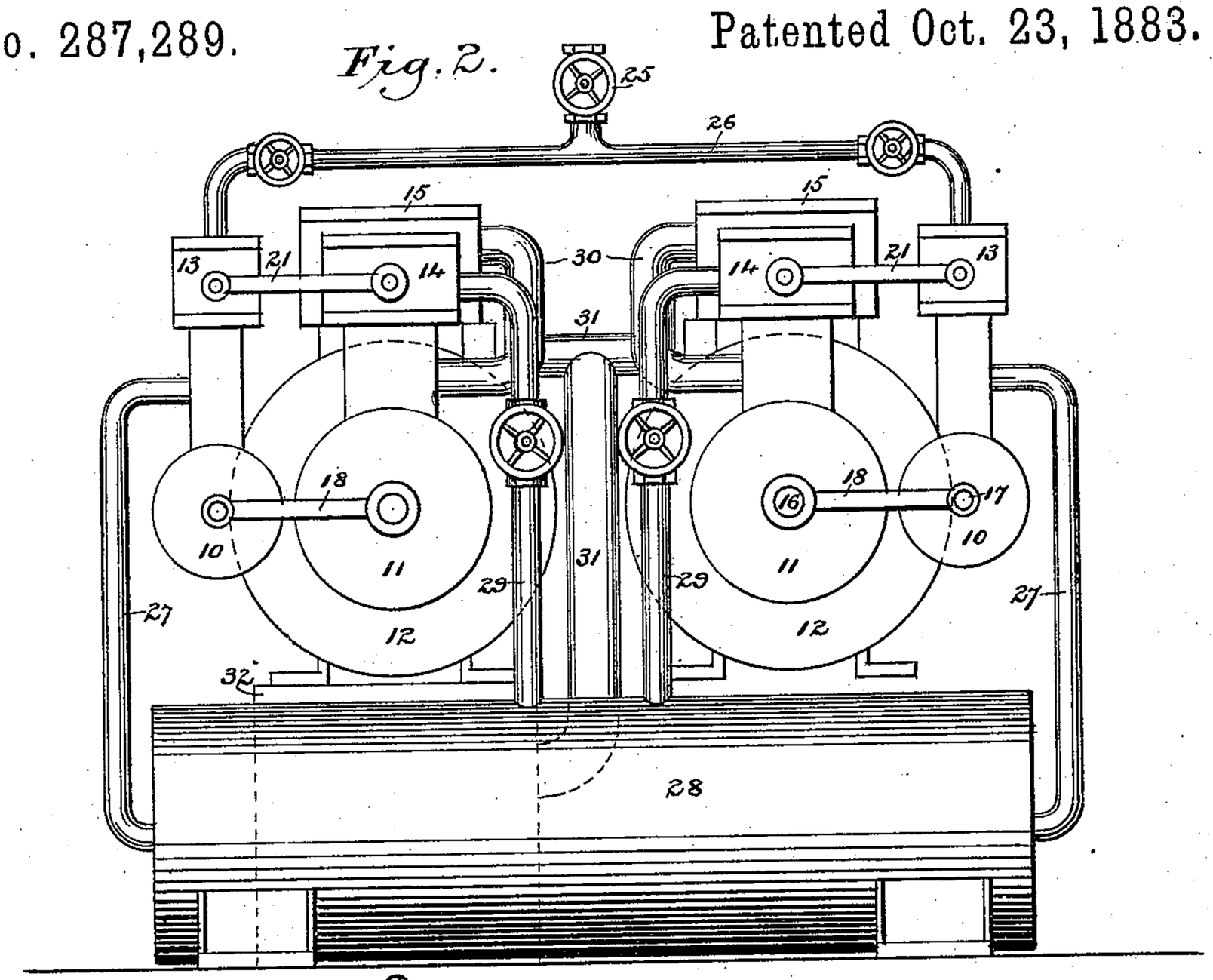
2 Sheets—Sheet 1.

F. W. JENKINS.

DIRECT ACTING COMPOUND ENGINE.

No. 287,289. Patented Oct. 23, 1883.

Fig. 2.



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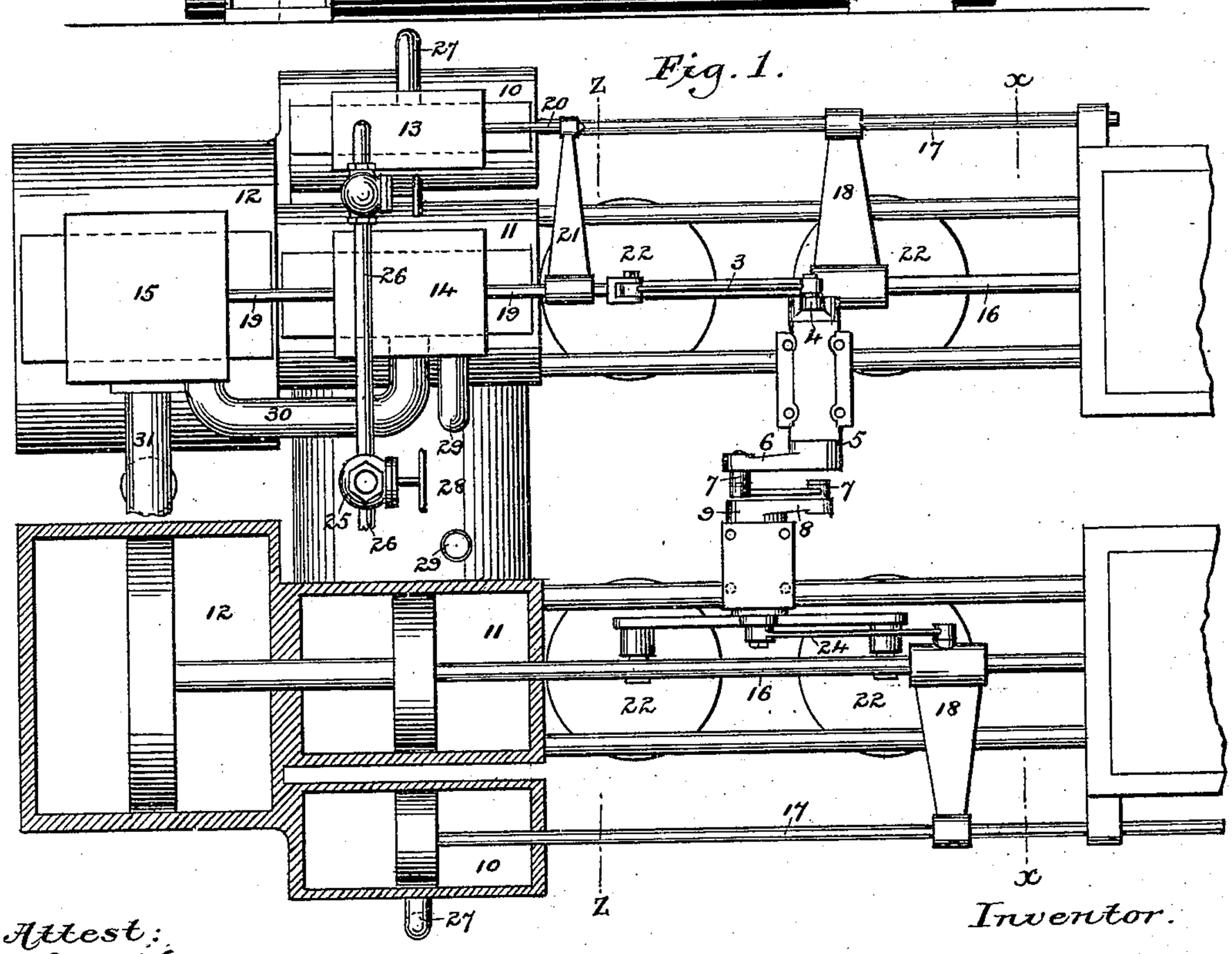

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A. N. Jasbera.

Inventor.
Frank W. Jenkins
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(No Model.) 2 Sheets—Sheet 2.

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Fig. 4.

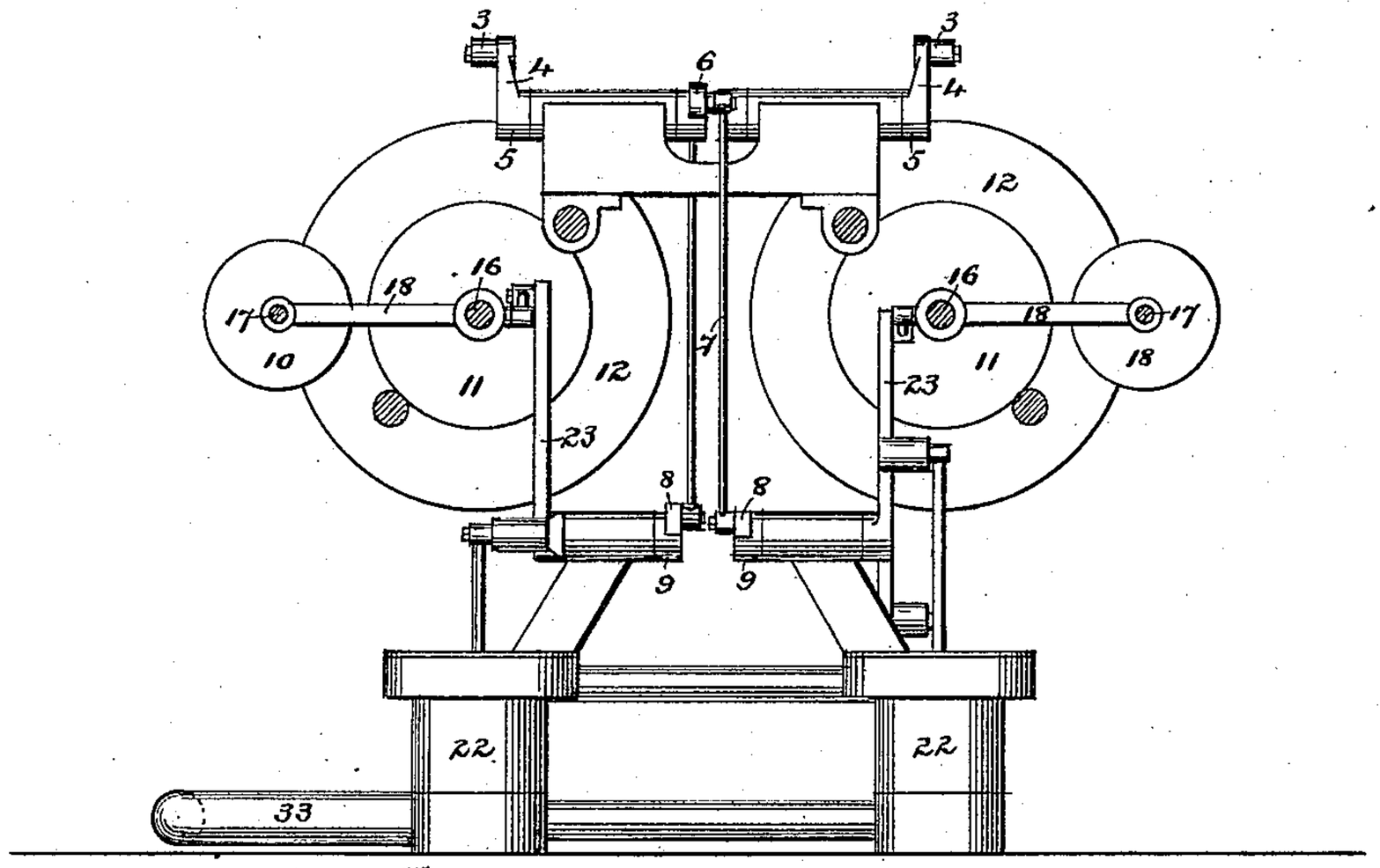
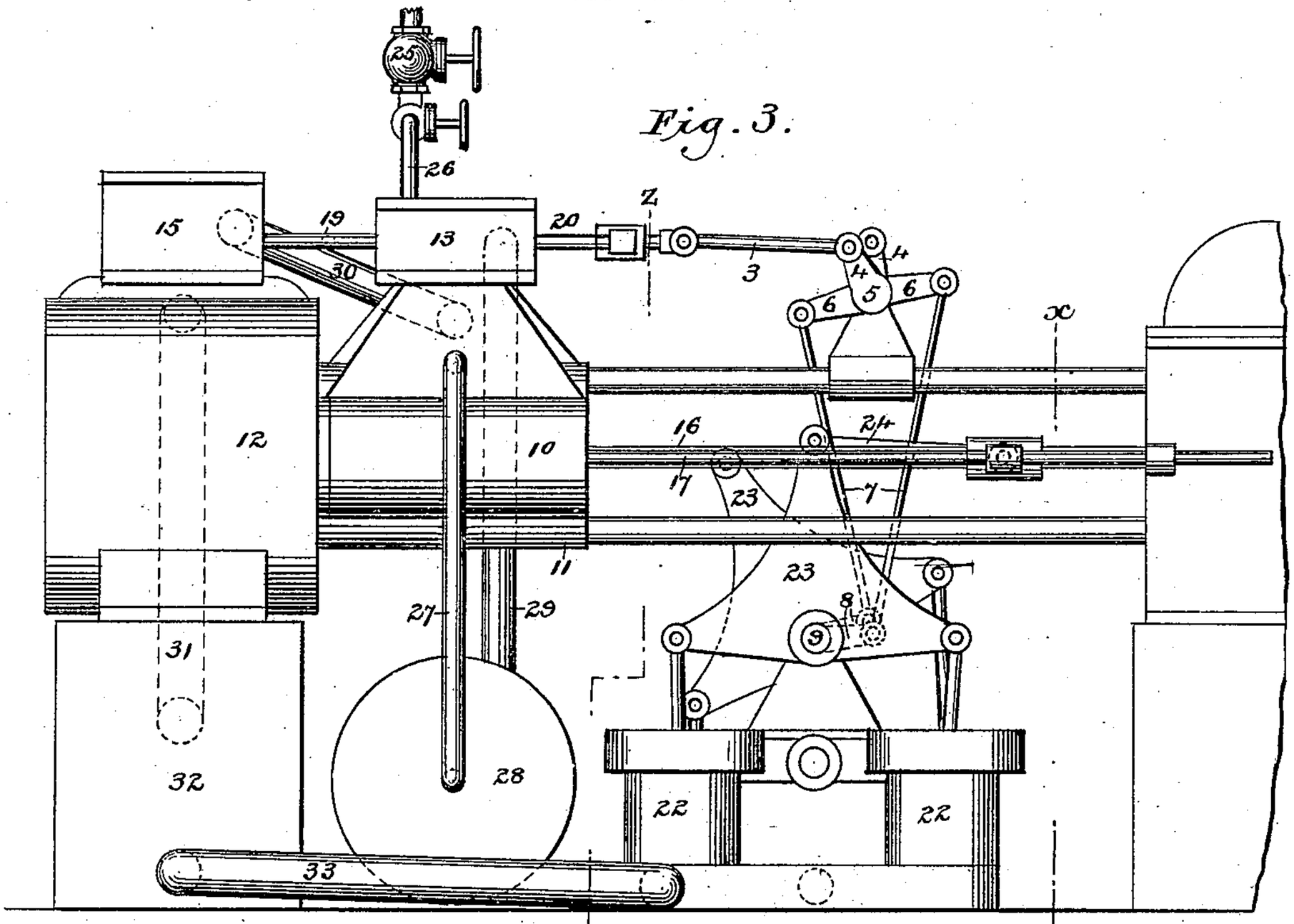


Fig. 3.



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x Inventor,
Frank W. Jenkins,
by Munson & Philipp
Att'ys.

UNITED STATES PATENT OFFICE.

FRANK W. JENKINS, OF BROOKLYN, NEW YORK.

DIRECT-ACTING COMPOUND ENGINE.

SPECIFICATION forming part of Letters Patent No. 287,289, dated October 23, 1883.

Application filed August 23, 1883. (No model.)

To all whom it may concern:

Be it known that I, FRANK W. JENKINS, a citizen of the United States, residing in the city of Brooklyn, county of Kings, and State of New York, have invented certain new and useful Improvements in Direct-Acting Compound Engines, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

This invention relates to direct-acting engines generally, but more particularly to engines of the class shown and described in United States Letters Patent No. 24,838, and known as the "Worthington Duplex Pumping-Engine." In order to secure the successful operation of this class of engines, the two following conditions must be maintained: First, a uniform or nearly uniform propulsive power must be maintained throughout the entire stroke of the engine; and, second, the propulsive energy of the steam must be so divided that each side of the engine will develop one-half the total power. The first of these conditions is imposed by the fact that no balance-wheel is used, and as the load upon the engine is uniform, or nearly so, throughout the entire stroke, any considerable falling off in the power applied to the steam-pistons would result in slowing and finally stopping the engine before it had reached the end of its stroke. The second condition is imposed by the necessity of having the pistons or plungers of both of the pumps of the same size, which is requisite in order to secure a steady and uniform discharge of water.

It is well known to those familiar with the science of steam-engineering that steam can be most economically used at a comparatively high pressure, and also that in order to utilize the largest proportion of the power generated it is necessary to use the steam expansively. In using steam upon this principle, however, its propulsive force necessarily decreases toward the end of the stroke, and this decrease, unless compensated for, results in a spasmodic operation of the engine and destroys the first of the conditions above named. This being the case, it has been found impracticable, in direct-acting engines, to utilize the expansive energy of the steam to any considerable extent, except by the employment of compound cylinders, and even by this means the amount of expansion permissible is comparatively limited.

It is the object of the present invention to produce a direct-acting engine in which the steam can be first used at a high pressure, and exhausted only after its expansive energy has been nearly or quite expended, and in which a uniform propulsive power will be maintained throughout the entire stroke.

To that end the invention consists, broadly, in a direct-acting engine having one or more cylinders which are arranged to receive steam direct from the boiler and discharge it into a tank, a second cylinder arranged to receive steam from said tank, and a third cylinder arranged to receive steam from the exhaust of the second.

The invention also embraces various combinations and organizations in a duplex engine, all of which will be hereinafter fully explained and particularly pointed out.

In the accompanying drawings, Figure 1 is a plan view, partly in section, of a duplex pumping-engine embodying the present invention. Fig. 2 is a transverse vertical section taken upon the line *z z* of Figs. 1 and 3. Fig. 3 is a side elevation of the same, and Fig. 4 is a diagrammatic section taken upon the line *x x* of Figs. 1 and 3.

Referring to said figures, it will be seen that the opposite sides of the engine are exact duplicates, each consisting of one high-pressure cylinder, 10, which receives its steam direct from the boiler and discharges it into a tank, one high-pressure cylinder, 11, which receives its steam from said tank, and one expanding low-pressure cylinder, 12, which receives its steam from the cylinder 11 and exhausts it into a condenser, the cylinders 11 12 being arranged to operate upon the well-known compound principle. These cylinders, although here shown as made in one piece and integral with each other, for convenience of illustration, will of course be constructed and supported in the usual manner. The cylinders 10 11 12 are provided with the usual pistons, the rod or rods of which are connected directly to the load, which in the case shown is

the plungers or pistons of the pumps. The pistons of the several cylinders may be provided with independent rods; but as here shown the pistons of the cylinders 11 12 of each side of the engine are attached to a single rod, 16, while the pistons of the cylinders 10 are provided with independent rods 17, which are connected to the rods 16 by cross-heads 18. The several cylinders are provided with the usual steam-chests, 13 14 15, the valves of the chests 14 15 upon each side of the engine being operated by a single rod, 19, while the valves of the chests 13 are operated by independent rods 20, which are connected to the rods 19 by cross-heads 21, so that all of the valves of each side of the engine are operated simultaneously. Each side of the engine is provided with the usual air-pumps, 22, for withdrawing the water and vapor from the condenser, which are operated from the piston-rods 16 through links 24 and double bell-crank levers 23, all arranged in the usual manner. The valve-rod 19 of each side of the engine is operated, as is common in duplex engines, by the piston-rod of the opposite side through a link 3, rock-arm 4, rock-shaft 5, rock-arm 6, link 7, and rock-arm 8, extending from the shaft 9 of the lever 23, all of which parts are arranged in the common and well-understood manner.

The operation of the engine thus organized is as follows: The throttle 25 being opened, the steam will pass from the boiler through the pipe 26 to the cylinders 10, where it will act upon the pistons of said cylinders at its full pressure throughout the whole stroke. As the pistons in these cylinders commence their return-stroke, the steam already in the cylinders will pass through the pipes 27 and enter the tank 28 at a reduced pressure. The tank 28, which is thus kept supplied with steam, serves as a boiler or reservoir from which the steam is supplied to the cylinders 11. At the same time that the steam is admitted to the cylinders 10 from the boiler it is admitted from the tank 28 through the pipe 29 to the cylinders 11, in which cylinders it will act at the full tank-pressure throughout the whole stroke, after which, as the pistons in said cylinders commence their return-stroke, the steam already in the cylinders will pass through the pipes 30 into the cylinders 12, where it will act expansively upon the pistons of said cylinders. After performing its work in the cylinders 12 and parting with nearly or quite the whole of its expansive energy, the steam will be exhausted through the pipes 31 into the condenser 32, from which, as before stated, the water and vapor will be drawn through the pipe 33 by the pumps 22. The connections by which the valves of each side of the engine are operated by the movement of the other side will of course be so adjusted as to properly time the movements of the two sides with relation to each other. The cylinders 10 are of such size with relation to the cylinders 11 as to maintain the proper pressure in the tank 28. The cylinders 11 12 are of such relative size that the steam acting upon their pistons, as just described, will exert a nearly or quite uniform propulsive power throughout the entire length of the stroke, and as the propulsive power exerted by the cylinders 10 is uniform throughout the entire stroke, it follows that the power exerted by the entire engine is uniform throughout the entire stroke.

By the employment of the high-pressure cylinders 10 the steam can be received from the boiler at a comparatively high pressure, so that after performing its work in said cylinders it can be exhausted into the tank at as high a pressure as would be maintained in the boiler if only the cylinders 11 12 were employed, thereby gaining all the advantages due to the use of the steam at a high initial pressure, and at the same time the benefits of as high a ratio of expansion as is permissible without destroying the uniformity of the propulsive power of the engine.

In those engines in which the steam, after being used in one cylinder, is discharged into a tank from which it is drawn into a larger cylinder to be used a second time, it has been found difficult to maintain as uniform a pressure in the tank as is desirable. This lack of uniformity arises from the fact that as soon as the exhaust-valve of the discharging-cylinder is opened, the entire contents of that cylinder immediately expands into the tank, thereby raising the pressure more or less, according to the size of the tank, the pressure then being gradually lowered as the receiving-cylinder is filled. This irregularity, which, although not fatal, is very objectionable in a direct-acting engine, is overcome in the present organization by connecting the cylinders 10 11 of both sides of the engine with the same tank.

It is well known to those familiar with the operation of duplex engines that the valves are so operated that one side of the engine will commence its stroke just before the opposite side has completed its stroke in the same direction, from which it results, in the present organization, that at the time when the pressure in the tank is being lowered by the withdrawal of steam to fill the cylinder 11, upon one side of the engine, and just at the point when such reduction in pressure is being most felt by the engine, the tank is replenished and its pressure restored by the discharge of steam from the cylinder 10 of the opposite side of the engine, thus neutralizing the reduction in pressure caused by the withdrawal of steam and maintaining a practically uniform pressure in the tank.

Although, for the reason just stated, the present invention is especially applicable to duplex engines, yet it will readily be seen that it may be applied with advantage to single as well as duplex engines.

The relative sizes of the several cylinders

may of course be varied to suit local conditions and to secure the results specified, the proportions shown in the drawings being only an approximation of the proper proportions, for the purpose of illustrating the principle and operation of the invention.

In some cases it may be found desirable to provide the engine, or each side of the engine, if it be of duplex form, with more than three cylinders, and this can be done, if desired, without departing from or losing the advantages of the invention.

In some cases it may be found desirable to provide the engine, or each side of the engine, with two or more of the cylinders 10, which shall be arranged to receive steam direct from the boiler and discharge it into the tank. The cylinder or cylinders 10 will preferably be located at the side of the cylinder 11, as shown in the present case, as this arrangement produces a very compact organization and renders the parts easily accessible. They may, however, if desired, be arranged in any other convenient position. If preferred, all three of the cylinders may be arranged upon the same axial line, so that their pistons can be secured to a single rod; or all or any two of the cylinders may be arranged in the well-known annular form; or any other convenient or desirable arrangement may be adopted.

Although it is preferable that both of the cylinders 10 should discharge into the same tank, yet a part of the advantages of the invention may be realized by the employment of separate tanks for the two cylinders.

What I claim is—

1. In a direct-acting engine, the combination, with the cylinder 10, arranged to receive steam direct from the boiler and discharge it into a tank, of the cylinder 11, arranged to receive steam from said tank, and the cylinder 12, arranged to receive steam from the exhaust of the cylinder 11, substantially as described.

2. A duplex engine, each side of which is provided with a cylinder, 10, which receives steam direct from the boiler and discharges it into a tank, a cylinder, 11, which receives steam from the tank, and a cylinder, 12, which receives steam from the exhaust of the cylinder 11, substantially as described.

3. A duplex engine, each side of which is provided with a cylinder, 10, which receives steam direct from the boiler, and discharges it into a common tank, 28, a cylinder, 11, which receives steam from said tank, and a cylinder, 12, which receives steam from the exhaust of the cylinder 11, substantially as described.

4. A duplex engine, each side of which is provided with a cylinder, 10, which receives steam direct from the boiler and discharges it into a tank, a cylinder, 11, which receives steam from the tank, a cylinder, 12, which receives steam from the exhaust of the cylinder 11, and connections by which its inlet and outlet valves are operated by the opposite side of the engine, substantially as described.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

FRANK W. JENKINS.

Witnesses:
J. A. HOVEY,
T. H. PALMER.