April 25, 1933. J. V. GIESLER 1,905,585

STEAM ENGINE

Filed March 19, 1930 3 Sheets-Sheet 1

Fig. 1.

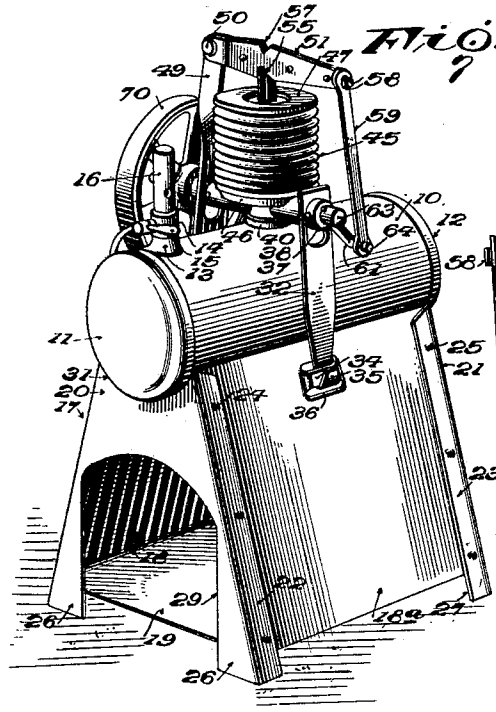


Fig. 2.

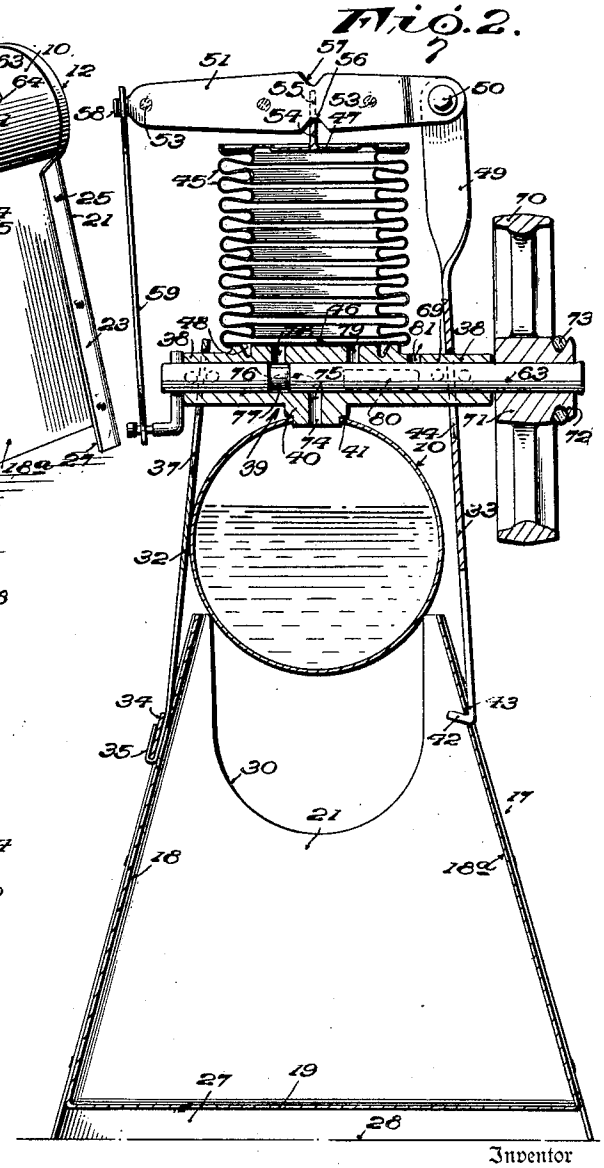
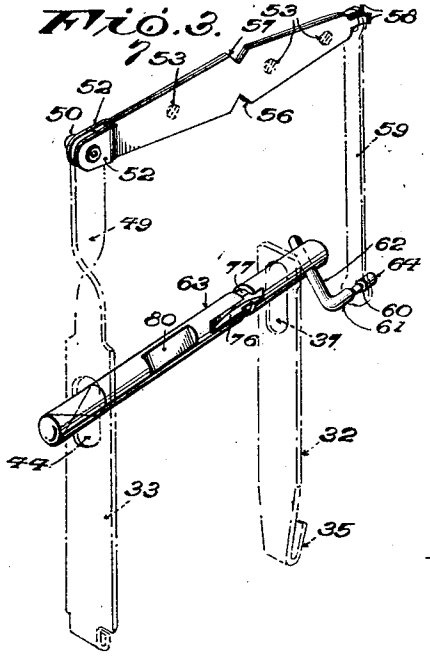


Fig. 3.



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Fig. 4.

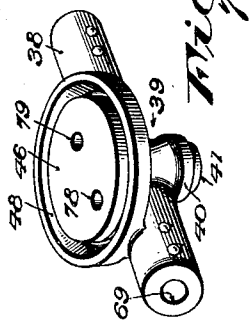


Fig. 5.

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STEAM ENGINE

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Fig. 6.

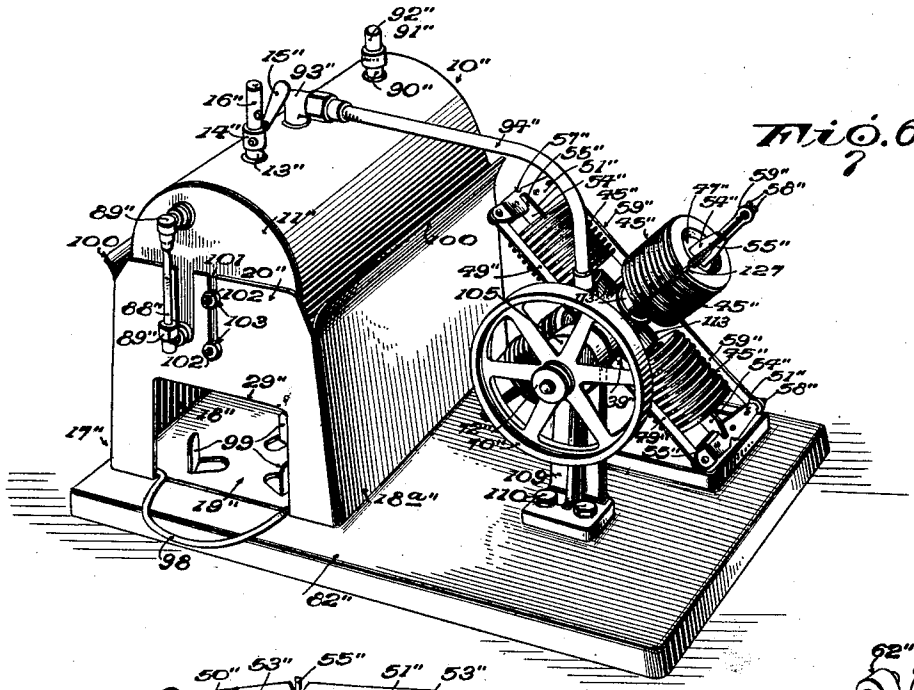


Fig. 7.

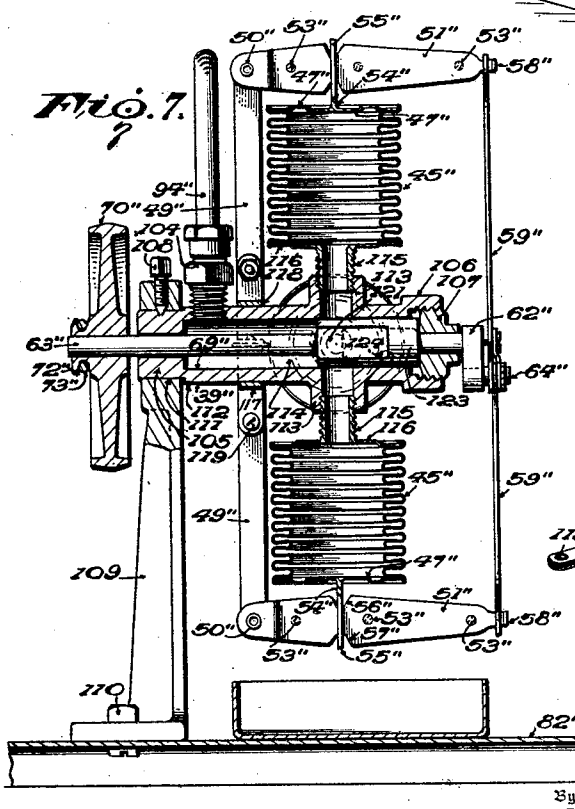


Fig. 8.

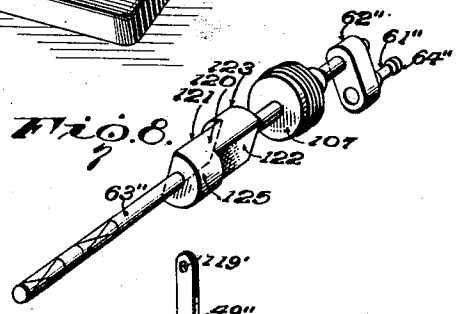
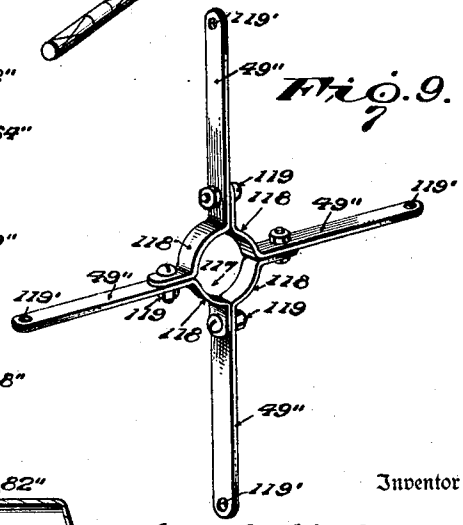


Fig. 9.



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UNITED STATES PATENT OFFICE

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STEAM ENGINE

Application filed March 19, 1930. Serial No. 437,173.

This invention relates to engines, and while capable of general use, is particularly adapted for embodiment in toy engines operated by steam, hot air, compressed air, or the like.

In my Patent No. 1,628,138, granted May 10, 1927, there is disclosed and claimed an engine having a cylinder comprised by an expansible and collapsible vessel into and from which, steam, or hot air, or compressed air, etc., is admitted and exhausted, respectively, through the provision of a valved crankshaft and housing interposed between said vessel and a fluid containing tank on which the aforesaid parts are mounted. The present invention is an improvement on the engine dislosed and claimed in said patent, and has for an object the provision of a novel construction in which the crankshaft and housing therefor are so made as to afford increased rigidity, strength and durability, and the number of parts of the engine are reduced, with a corresponding reduction in labor and manufacturing costs.

Another object of this invention is to provide an engine of the type above referred to, which has novel and improved means for utilizing the expanding action of the vessel to operate said engine.

Another object of this invention is to provide a novel engine of the type having an expansible and collapsible cylinder, which may be mounted upon, or independently of, the fluid containing tank, as desired.

Another object of this invention is to provide an engine constructed, if desired, in the form of a toy, and having novel and improved parts which are durable and inexpensive and can be supplied as standard equipment for the engine whether it is comprised by one cylinder or a plurality of cylinders.

Another object of this invention is to provide a novel engine which has a solid valved or ported crankshaft constructed so that admission of the motive fluid to, and exhaust of the same from, the collapsible and expansible vessel, may be controlled in an improved and expeditious manner.

Another object of this invention is to provide a novel engine having a plurality of radially extending collapsible and expansible vessels which form a corresponding number of cylinders for the engine and are associated with novel fluid controlling and power transmitting devices.

These and other objects of this invention will appear as the following description thereof proceeds. In order to more clearly understand said invention, reference may be had to the accompanying drawings which illustrate several embodiments of the inventive idea, and wherein

Fig. 1 is a detail perspective view of one embodiment of the invention wherein the engine is comprised by a single expansible and collapsible cylinder mounted on a boiler or fluid containing tank carried by a sheet metal base;

Fig. 2 is an enlarged transverse vertical sectional view of the engine, tank, and base shown in Fig. 1;

Fig. 3 is a detail perspective view of the valved or ported crankshaft and the power transmitting device, shown in Fig. 2;

Fig. 4 is a detail perspective view of a cast metal support for the expansible and collapsible cylinder;

Fig. 5 is a detail perspective view of an embodiment of the invention similar to that shown in Fig. 1, but wherein the engine is mounted independently of the boiler or fluid containing tank.

Fig. 6 is a detail perspective view of another embodiment of the invention, wherein the engine shown is comprised by a plurality of radially extending cylinders mounted independently of the boiler or fluid containing tank;

Fig. 7 is an enlarged sectional view of the engine shown in Fig. 6, the section being taken in the direction of the length of a pair of the opposed radially extending cylinders of the engine;

Fig. 8 is a detail perspective view of the valved or ported crankshaft shown in Fig. 7; and

Fig. 9 is a detail perspective view of sup-

porting means for the power transmitting devices shown in Figs. 6 and 7.

Referring to the drawings, wherein like reference characters indicate like parts throughout the several views, the embodiment of the invention shown in Figs. 1 to 4, inclusive, includes a boiler or fluid containing tank 10 of any suitable size, shape and material, the same being preferably formed as a cylindrical vessel of sheet or drawn metal having ends 11, 12 suitably soldered or brazed thereto. A suitable filling opening, for the boiler or fluid containing tank 10, is provided by a nipple 13 which may be closed by a threaded plug 14. The plug 14 may, if desired, be provided with a valve 15 for a whistle 16 which is suitably soldered or brazed to said plug and communicates with the interior of the boiler or fluid containing tank 10 when said valve is opened.

The boiler or tank 10 is mounted on a generally rectangular housing 17, which may desirably be formed of sheets of metal that are brazed or spot welded together to thus provide a simply constructed, inexpensive, and extremely rigid and durable support for the boiler and the engine. As herein shown, the side walls 18, 18ª of the housing 17, and the bottom wall 19 thereof, are formed of a single sheet of metal bent so that when the parts of the housing are assembled, the side walls 18, 18ª are inclined upwardly and inwardly with respect to each other and the bottom wall 19 extends horizontally between said side walls and forms a shelf or the like for a suitable heater (not shown) employed to heat the water or fluid in the boiler or tank 10. The end walls 20, 21 of the housing 17 are provided at their opposite sides with flanges 22 and 23, respectively, inclined in conformity with the inclination of the side walls and bent over and suitably soldered or spot welded to said side walls, as at 24 and 25. The end walls 20, 21 of the housing 17 are of greater height than the side walls 18, 18ª thereof, and said end walls thus provide legs 26, 26, and 27, respectively, on which the housing proper is supported with the bottom or shelf 19 thereof spaced from the surface 28 on which the housing is placed. The end wall 20 of the housing is provided with an opening 29 through which the aforesaid heater may be moved to and from its position on the shelf or bottom 19 of the housing, as desired. The end wall 21 of the housing is provided at the top thereof with one or more openings 30 for the escape of the hot air or products of combustion generated by the heater and utilized in heating the water or fluid in the boiler or tank 10.

The boiler or tank 10 is supported on the upper part of the housing 17 and projects therein a distance sufficient to afford an adequate heat conducting surface against which the hot air or products of combustion are directed from the heater within said housing. One end of the boiler or tank 10 is supported on the edge of an opening 31 formed in the upper end of the wall 20. The opposite end of the boiler or tank 10 is supported on the edge of the opening 30, at the top of the wall 21. The boiler or tank 10 is secured in position on the housing 17 with the aid of metal straps or the like 32 and 33. The lower end of the strap 32 extends between the side wall 18 and a lug 34, said lower end of the strap being bent to form a hook 35 that is engaged under the lower edge of said lug. The lug 34 projects outwardly from the side wall 18 to provide openings 36 (Fig. 1) through which the lower end of the strap 32 may be passed to bend and engage the hook 35 thereof with the lower edge of the lug 34. Said lug is preferably formed integrally with the side wall 18, as by stamping or punching the same outwardly therefrom.

The upper end of the strap 32 is provided with an elongated opening 37, and the open upper end of said strap is secured over one end of a tubular boss 38 that extends transversely of the boiler or tank 10 and outwardly in opposite directions from a metallic casting or support 39, (Fig. 4). The boss 38 is preferably formed integrally with the casting 39, and said casting is provided with a nipple 40 that is preferably formed integrally with the boss 38 centrally with respect to the opposite ends thereof. The casting 39 is mounted on the top of the boiler or tank 10, and said casting is suitably brazed or soldered to said boiler or tank at the junction of a shoulder 41 with the edge of an opening in the boiler or tank at the top thereof. The shoulder 41 is provided by a reduced portion of the nipple 40 that projects slightly into the boiler or tank 10, as clearly shown in Fig. 2 of the drawings.

The strap 33 is provided on its lower end with a hook 42 that is engaged under the top edge of an opening 43 formed in the upper part of the side wall 18ª. This strap 33 is provided intermediate its opposite end with an elongated opening 44, the open intermediate portion of the strap 33 being engaged over the end of the boss 38 opposite that engaged by the upper end of the strap 32. It will appear, from the foregoing, that the straps 32, 33 and the boss 38 of the casting 39, serve to hold the boiler or tank 10 securely in position on the housing 17, the straps 32, 33 at the same time affording additional means for securing and holding said casting in position on the top of said boiler or tank.

Mounted in any suitable way, as on the casting 39, is an expansible and collapsible vessel 45 of any suitable form, but pref-

erably having a deeply corrugated flexible tubular wall of resilient metal, said vessel being closed at its opposite ends by end walls 46 and 47. The end wall 46 is preferably provided by an annular, upwardly disposed extension of the casting 39, and said extension has suitably formed therein an annular groove 48 on the wall of which is suitably brazed or soldered the adjacent end of the vessel 45. The end wall 47 of said vessel is preferably comprised by a relatively thin, annular metal plate on the peripheral portion of which is suitably brazed or soldered the adjacent end of the vessel 45.

In accordance with the present invention, novel means are provided for transmitting power to operate the engine by expansion and contraction of the vessel 45, and said means are preferably constructed and operated as follows.

The strap 33 is provided above the boss 38 with a bent or twisted lever support 49 having an opening therein for a bolt or rivet 50 on which is pivotally mounted a lever 51 which is bifurcated at one end to provide ears 52. The ears 52 engage over opposite sides of the lever support 49, and are provided with suitable openings which receive the bolt or rivet 50 and are formed in said ears in alignment with each other and with the opening in the lever support 49. Lever 51 is preferably formed of sheet metal and, as herein shown, is made in two coextensive parts connected together at 53, 53, as by spot welding or rivets. Each part of the lever 51 has formed on one end thereof, one of the ears 52, 52. The movable end wall 47 of the collapsible and expansible vessel 45, is provided with a suitable thrust element or post 54 which is preferably made of sheet metal and secured to or formed integrally with said end wall 47. The upper portion of this thrust element is designed to contact the under side of the lever 51 and provide a one-way driving connection therewith.

In order to provide for relative movement between the thrust element or post 54 and the lever 51, in the direction of the longitudinal axis of the vessel 45, and to insure against relative lateral displacement of the lever 51 and said thrust element or post, the latter is bifurcated at its free end to provide prongs 55, 55 which engage opposite sides of the lever 51 and are prevented from moving in the direction of the length thereof by a wedge shaped notch 56 formed in the lower edge portion of the lever 51 intermediate the opposite ends thereof. The reduced terminal portion of the notch 56 engages the thrust element or post 54 at the bottom of the prongs 55, 55 during the normal operation of the engine affected by expansion and contraction of the collapsible and expansible vessel 45 as hereinafter described. The above described one-way driving connection for the lever 51 with the vessel 45 will, in the event steam is employed as the motive agent, greatly facilitate the starting of the engine for, as pointed out in my Patent No. 1,628,138, the first expansions of the vessel do not appear to be complete expansions, probably because of condensation of steam in the vessel 45 until its walls become sufficiently heated. Under these conditions, the thrust element or post 54 is not moved its full stroke during the first few operations, and there is consequently relative movement in the direction of the length of the vessel 45, between the lever 51 and the thrust element or post 54, which relative movement is permitted by the above described one-way driving connection between these parts. The prongs 55, 55 and the inclined edges of the notch 56, insure engagement of the thrust element or post 54 with the lever 51 under normal operating conditions, and also prevent lateral and longitudinal displacement of these parts with respect to each other under any condition of operation of the engine, as well as when the same is not in use.

Aligned with the notch 56 and formed in the edge of the lever 51 opposite that provided with said notch, is a similar notch 57, the shape of the latter being identical with that of the former. The provision of the two notches 56, 57 in the opposite longitudinal edges of the lever 51, facilitates and speeds up assembly of the parts, in that no particular attention is required in mounting the lever with a selected edge thereof faced toward the thrust element or post 54, since it is obvious that the latter would properly engage the lever regardless of the edge thereof positioned between the prongs 55, 55.

The lever 51 has secured to, or formed integrally therewith, bendable securing means or prongs 58 which project from the free end of said lever to pivotally receive the apertured upper end of a link 59. In the event the lever 51 is formed of two coextensive parts riveted together, as herein shown, one of said prongs is secured to or formed integrally with each part of said lever at the free end thereof. The prongs 58 are bent outwardly with respect to each other after the upper end of the apertured link 59 has been placed thereon, so that said link is securely held against accidental displacement from said lever..

The lower apertured end of the link 59 is rotatably received by the reduced portion 60 of a crank pin 61 on which said link is secured against accidental displacement by a cap 64 or the like screwed onto the reduced portion of said crank pin. The link 59 is preferably formed of sheet metal or the like, and the crank pin 61 is preferably formed integrally with a crank 62 cut from round

metallic stock of such character as to enable the crank to be bent angularly to form the pin 61. The crank 62 is mounted on a solid crankshaft 63 and extends through, and has a pressed fit with, an opening formed in one end of said shaft. The crankshaft 63 is rotatably mounted in, and has a fluid tight fit with, a tubular bore 69 extending longitudinally through the boss 38 of the casting 39. The shaft 63 is inserted in the bore 69 through one end of the boss 38, the crank 62 extending diametrically across, and being disposed outwardly of, said end of said bore. The opposite end of the shaft 63 projects beyond the opposite end of the boss 38, and carries a flywheel 70 that is secured in any suitable manner to said shaft after it has been positioned in said bore. The hub 71 of the flywheel 70 has secured to or formed integrally therewith, a pulley 72 adapted to receive a belt 73 by means of which power is delivered from the engine for driving any desired device or instrumentality.

The shaft 63 and the casting 39 are designed to constitute a valve mechanism for admitting steam, or hot air, or compressed air, etc., from the boiler or tank 10 to the vessel 45 and for exhausting the fluid therefrom. To this end, a conduit 74 formed in the nipple 40 leads from the interior of the boiler or tank 10 to a port 75 formed in the bore 69 of the boss 38. This port 75 is adapted, at intervals, to register with one end of an arcuate shaped port 76 formed in the shaft 63 on the periphery thereof and extending longitudinally of said shaft. The opposite end of the port 76 extends transversely of an annular port 77 formed on the shaft 63. This port 77 is continuously in register with a port 78 or fluid conducting means extending through the plate-like extension of casting 39 and forming the adjacent end wall of vessel 45, the port 78 thus communicating with the interior of said vessel. Each time the port 76 is rotated into registry with the port 75 (steam or other motive fluid in the boiler or tank 10, will pass through the conduit 74 and the ports 75, 76, 77, 78, into the collapsible and expansible vessel 45. After each admission of the steam or other motive fluid to the interior of the vessel 45, it is exhausted therefrom, after a suitable interval, through a port or fluid conducting means 79, and ports 80, 81, to the atmosphere. The fluid conducting means or port 79 communicates with the interior of the vessel 45 and extends through the end wall thereof provided by the plate-like extension of casting 39. This port 79 is preferably arranged in spaced parallel relation with the port 78. The port 80 is formed on the periphery of the shaft 63 and extends longitudinally thereof in spaced relation with the ports 76 and 77. The port 80, on rotation of the shaft 63, is intermittently brought into register with the ports 79 and 81, the port 81 being formed in the boss 38 at a point close to the vessel 45. The port 81 and the ports 79 and 80 serve to exhaust the fluid from the vessel 45 when the port 80 is rotated into registry with the ports 79 and 81. The provision of a solid crankshaft, and the location of the port 81 close to the vessel 45, enables steam to be exhausted from said vessel in a manner such that there is no danger of burning the operator or attendant. This is a desirable feature, particularly when the invention is embodied in an engine to be handled and operated by children.

In operation, the fluid in the boiler or tank 10 is heated by the device for this purpose placed on the bottom or shelf 19 of housing 17, and when a sufficiently high temperature of said fluid has been attained, the engine may be started by giving an initial rotary impulse to the flywheel 70 or the shaft 63 whereupon the engine will continue to run as long as the contents of the boiler or tank 10 are maintained at proper temperature. When the shaft 63 rotates into the position shown in Fig. 2, the ports 75 and 76 are in register and the steam or heated fluid may thereupon flow from the boiler or tank 10 through the conduit 74 and the ports 75, 76, 77, 78, into the interior of the vessel 45, where the application of pressure to the movable end wall 47 causes said vessel to expand and the thrust element or post 54 to move the lever 51 from its lower to its upper position. This movement of the lever 51 is transmitted through the link 58 to the crank 62 to rotate the shaft 63. During the rotation of said shaft and after admission of fluid into the vessel 45, the port 76 is moved out of registry with the port 75 so that fluid is prevented from entering the vessel 45 until said ports are again brought into register. After the ports 75, 76 are moved out of register, the port 80 through continued rotation of the shaft 63 is brought into register with the ports 79 and 81 so that the steam or fluid in the vessel 45 may escape through said ports to the atmosphere. This reduction of pressure in the vessel 45 enables the resilience inherent in the corrugated wall of the vessel to return the same to unexpanded condition, and the lever 51 will follow the thrust element or post 54 as the vessel 45 returns to unexpanded condition, the momentum of the shaft 63 and the flywheel 70 being sufficient to carry said shaft through the remainder of its cycle of revolution until the admission ports are again brought into register to permit a fresh flow of fluid into the vessel 45 and produce a new expansion of said vessel and a new thrust on the lever 51. It will therefore appear that the shaft 63 is rotated by the os-

cillation of the lever 51 which in turn is caused by the expansion and contraction of the vessel 45, while the shaft 63, by its rotation and construction, constitutes with the casting 39 the valve mechanism for admitting and exhausting fluid to and from the interior of said vessel.

The construction and operation of the embodiment of the invention shown in Fig. 5, is identical with the construction and operation of the embodiment of the invention shown in Figs. 1 to 4, inclusive, except that the engine and the boiler or tank are, as shown in Fig. 5, mounted independently of each other, instead of one upon the other, as shown in Figs. 1 to 4, inclusive. The same reference characters are employed for corresponding parts of the engine shown in Figs. 1 to 4, inclusive, and Fig. 5, except that in the latter, said reference characters are primed. If it is desired to mount the engine independently of the boiler or tank, the two may, by way of example, be secured in vertically spaced relation on a bed plate 82 (Fig. 5) of general rectangular shape and preferably pressed or stamped from sheet metal or the like. The bottom of the boiler or tank 10′, in this case, is preferably provided with a flange 83, and said boiler or tank is secured to said bed plate by screws or the like 84 which pass through suitable openings in the flange 83 and have threaded engagement with the walls of suitable openings formed in the bed plate 82. The water or fluid in the tank 10′ may, if desired, be heated by a suitable electric heater 85 secured in any suitable manner to the boiler or tank 10′ and projecting therein through a suitable opening or openings, formed in the wall of said boiler or tank. The heater 85 may be connected with and disconnected from any suitable source of electric current by means of leads 86, 87. In the event steam is to be employed for operating the engine, the boiler or tank 10′ may, if desired, be provided with a suitable water gauge 88 the opposite ends of which have the usual fittings 89, 89 secured to said boiler or tank and establishing communication between the latter and said gauge. The filling nipple 13′, plug 14′, valve 15′ and whistle 16′ are mounted on the upper end 12′ of the boiler or tank 10′, and in addition to these parts, there may be provided, if desired, a nipple 90 extending into the boiler or tank and suitably brazed or soldered to the upper end 12′ thereof. This nipple 90 is closed by a plug 91 provided with a safety or relief valve 92, or other desired attachment.

Mounted on the upper end 12′ of the boiler or tank 10′ and communicating with the interior thereof, is an L-shaped pipe union 93 that is suitably brazed or soldered to the boiler or tank end 12′. Connected with the union 93 is one end of a conduit 94 the opposite end of which is connected with the interior of a fluid tight base 95 on which the engine, proper, is mounted. This base 95 is provided at the bottom thereof with a flange 96 and said base is secured to the plate 82, in spaced relation with the boiler or tank 10′, by set screws or the like 97 which pass through suitable openings in said flange and have threaded engagement with the walls of similar openings formed in said bed plate. The nipple 40′ of the casting 39′ communicates with the interior of the tubular base 95 through a suitable opening formed in the top thereof, and said casting is suitably brazed or soldered to the top of said base at the junction of the nipple 40′ therewith. The steam or fluid generated or heated in the boiler or tank 10′ passes through the union 93, conduit 94, and base 95, and the admission of said steam or fluid to, and exhaust of the same from, the vessel 45′ is controlled to operate the engine in the same manner described in connection with the embodiment of the invention disclosed in Figs. 1 to 4, inclusive.

The invention may be embodied in a construction wherein said engine is comprised by a plurality of cylinders which, if desired, may be radially arranged. Said cylinders will preferably consist of collapsible and expansible metallic vessels having deeply corrugated flexible tubular walls of resilient metal closed at their opposite ends and associated with a solid valved or ported crankshaft and novel driving connections of the type above described. The multi-cylinder engine could be mounted on the boiler or tank, or the two could be mounted independently of each other in spaced relation on a suitable bed plate. In the embodiment of the invention shown in Figs. 6 to 9, inclusive, however, the boiler and the radial engine therein illustrated are mounted independently of each other in spaced relation on said bed plate, and the parts of the structure which correspond with the parts of the structures shown in Figs. 1 to 5, inclusive, are indicated by the same reference characters, except that in Figs. 6 to 9, inclusive, said reference characters are double primed. The bed plate 82″ for the radial engine shown in Figs. 6 to 9, inclusive, has mounted thereon a housing 17″ of general rectangular form that is suitably clipped, soldered or brazed to said bed plate at one end thereof. This housing 17″ has end walls and side walls, one of said end walls being indicated at 20″ and said side walls being indicated at 18″, 18a″. The end and side walls of the housing 17″ are preferably formed of a single sheet of metal bent into the shape of the housing which, as clearly shown in Fig. 6, is open at the top thereof. The bottom of the housing is closed by the bed plate 82″, or by a bottom wall 19″ suit-

ably clipped, brazed or soldered to said plate and to the end and side walls of said housing. The end wall 20″ of the housing 17″ is provided with a suitable opening 29″ through which an alcohol or other suitable heater (not shown) may be moved into and out of said housing. Movement of this heater into and out of the housing 17″ is facilitated by a curved guide 98 formed of spring wire or the like and having its ends suitably secured to the bottom of the housing at the rear of the end wall 20″ and at opposite sides of the opening 29″. The bed plate 82″, or the bottom wall 19″ of the housing may, if desired, have bent or struck upwardly therefrom supports 99 for the above mentioned heater. The upper corners of the housing 17″ are cut at the junction of the side and end walls thereof, so that the upper edges of said side walls may be bent outwardly to provide flared supports 100 for the boiler or tank 10″. Said boiler or tank extends within the housing and may be removably secured thereto on the end walls thereof. For this purpose, each end wall may be provided with a slot 101 for the reception of studs 102 projecting from the adjacent end of the boiler and threaded to receive nuts 103 by which the boiler or tank may be secured to and released from the adjacent end wall of the housing.

The steam, hot air, or other fluid employed to operate the engine, is fed from the boiler or tank 10″ through a conduit 94″ having one end connected with the union 93″ and its opposite end connected with a tubular fitting 104. The fitting 104 has threaded engagement with the wall of a suitable opening formed in a casting 39″ the tubular bore 69″ of which has an apertured end 105 secured to or formed integrally with said casting at one extremity thereof. The opposite extremity of the casting and the bore 69″ is enlarged at 106 to receive an apertured plug 107 threaded to, and removably secured on, the enlarged end of said casting, as clearly shown in Fig. 7 of the drawings. The casting 39″ is removably secured, as by a set screw 108, on a bracket 109, and projects horizontally therefrom. This bracket 109 is bolted or otherwise suitably secured, as at 110, to the bed plate 82″, and the upper end of said bracket is provided with an opening 111 which receives the end 105 of the casting 39″. A shoulder 112 bears against the bracket 109 at one side thereof, said shoulder being formed on the casting 39″ at the junction thereof with the end portion 105. The set screw 108, which engages the end 105 of the casting 39″, acts in conjunction with the shoulder 112, to prevent accidental endwise displacement of the casting 39″ on the bracket 109.

Arranged 90° apart around the casting 39″ and secured to or formed integrally therewith, are a plurality of outwardly projecting tubular bosses 113 or fluid conducting means adapted to communicate with the chamber 114 of the tubular bore 69″ at predetermined intervals during the operation of the engine. These bosses 113 have threaded on the outer ends thereof tubular extensions 115 of plates 116 that are suitably brazed or soldered to the deeply corrugated collapsible and expansible vessels 45″ and form the inner end walls thereof. Said vessels, herein shown as four in number, comprise a four cylinder radial engine the cylinders of which are arranged 90° apart in pairs at opposite sides of a vertical plane passing through the longitudinal axis of the tubular bore 69″. The vessels or cylinders 45″ are, through the medium of the plates 116 and their threaded extensions 115, rigidly secured on the bosses 113 of the casting 39″. The number of collapsible and expansible cylinders employed could be increased or decreased as desired, and said cylinders could be arranged on, and secured to, the tubular casting 39″ in any desired relation. Rigidly secured to the casting 39″, and mounted thereon between the fitting 104 and the vessels 45″, is a clamp 117 formed by the bent and curved arms 118 of lever supports 49″ that are bolted or otherwise suitably connected together, as at 119. The lever supports 49″ project radially from the casting 39″ in parallel relation with the longitudinal axes of the vessels 45″. The lever supports 49″ are preferably formed of sheet metal or the like, and as herein shown, said supports correspond in number with the vessels 45″ and project outwardly beyond the outer end walls 47″ thereof.

The lever supports 49″ are provided in the free ends thereof with openings 119′ for the reception of the pivots 50″ for levers 51″. These levers, as in the previously described embodiments of the invention, are notched at 56″, 57″ and extend between the prongs 55″ of the thrust elements or posts 54″ on the outer end walls 47″ of the vessels 45″. The prongs 58″ of the levers 51″ have pivotally connected therewith the outer ends of the links 59″. The inner ends of said links are pivotally connected with the pin 61″ of a crank 62″ that is fixed on one end of a solid crankshaft 63″. Accidental displacement of the inner ends of the links 59″ from the pin 61″ is prevented by a cap 64″ removably secured on the free end of said pin. Crankshaft 63″ is journaled in suitable fluid tight bearings provided in the apertures of the ends 105, 107 of the casting 39″ and said crankshaft extends longitudinally through the tubular bore 69″ of the casting 39″ and the chamber 114 thereof. Suitable packing, may if desired be employed to provide fluid tight joints be-

tween the ends 105, 107 of the casting and the crankshaft and, as herein shown, a portion of said crankshaft extends in spaced relation with a wall of the chamber 114 formed in said casting. The crankshaft 63″ projects outwardly beyond the opposite extremities of the casting 39″, one projecting end of said crankshaft having the crank 62″ secured thereon, and the opposite projecting end of the crankshaft having the flywheel 70″ secured thereon.

Rigidly mounted on, or integrally formed with, the crankshaft 63″ is a valve body 120 which rotatably engages the wall of the bore 69″ and is provided with valves or ports that control the admission of fluid to, and exhaust of the same from, the vessels 45″. This rotary valve body is provided 180° apart on its circumference with inlet and exhaust ports 121 and 122, respectively. The inlet port 121 extends from the left hand end of the valve body 120 (Figs. 7 and 8) toward the right hand end thereof where said inlet port is terminated by a valve 123 that controls the exhaust of the fluid from the vessel 45″ through the extensions 115, the bosses or fluid conducting means 113, and the exhaust ports 122 and 124. The four exhaust ports 124 lead from the interior of the casting 39″ to the atmosphere, and are formed in said casting between the enlarged end thereof and the bosses 113. The solid crankshaft 63″ and the location of the ports 124, as in the first described embodiment of the invention, enables steam to be exhausted from the engine without danger of burning the operator or attendant. The exhaust port 122 extends from the right hand end of the valve body 120 (Fig. 8) toward the left hand end thereof where said exhaust port is terminated by a valve 125 that controls the admission of fluid from bore 69″ to the vessels 45″ through the bosses 113 and extensions 115, respectively.

The above described radial cylinder engine is started by giving an initial rotary impulse to the flywheel 70″ or to the shaft 63″, whereupon the engine will continue to run as long as the steam or other fluid is supplied to the tubular bore 69″ by the boiler or tank 10″ and the conduit 94″. When the valve body 120 on shaft 63″ rotates therewith into the position shown in Fig. 7, inlet of fluid to the rearmost vessel 45″ therein shown is prevented by the valve 125, and fluid previously admitted to expand said vessel is exhausted therefrom through the port 122 and the port 124. At the same time, fluid from the chamber 114 of bore 69″ is admitted to the cylinder opposite said rearmost cylinder by the valve 123, and is retained in the former to expand the same. These two opposed cylinders are thus collapsed and expanded respectively, and impart motion to the crankshaft 63″ through the described connections therefor with said cylinders. Continued rotation of the shaft 63″ and the valve body 120 brings the inlet port 121 into registration with the uppermost boss 113 (Fig. 7) whereupon fluid is admitted from the chamber 114 of bore 69″, to the uppermost vessel 45″ and retained therein by the valve 123. At the same time communication between the bore 69″ and the lowermost vessel 45″ (Fig. 6) is cut off by the valve 125, and communication between said lowermost vessel and the atmosphere is established by the exhaust ports 122 and 124. The uppermost and lowermost vessels are thus expanded and collapsed, respectively, and thereby impart motion to the crankshaft 131. These operations are repeated in the successive opposed cylinders so that the crankshaft 63″ is continuously driven through the expansion and contraction of the vessels 45″ and the connections for said vessels with said crankshaft.

From the foregoing it will be perceived that in accordance with the present invention, a simple, compact, and inexpensive engine may be produced in models of one or a plurality of cylinders, and that in case a plurality of cylinders are employed, the same may be arranged radially, if desired. Further, it will be perceived that the novel driving connections afforded by the present invention prevent lateral displacement of the thrust element or post from the lever operated thereby, while at the same time maintaining these parts in predetermined alignment and providing for relative movement of the same when the engine is started and after it is in operation. The novel boiler or tank housings, and engine mountings, of the present invention are composed of a minimum number of rugged, easily manufactured parts that can be quickly assembled and connected with the engine, and this is also true with respect to the engine per se and the parts associated with and operated thereby.

While the several embodiments of the invention illustrated on the drawings have been described with considerable particularity, it is to be understood that the invention is not restricted thereto as the same is capable of receiving a variety of mechanical expressions, some of which will now readily suggest themselves to those skilled in the art, while changes may be made in the details of construction, arrangement and proportion of parts, and certain features used without other features, without departing from the spirit of this invention. Reference is therefore to be had to the claims hereto appended for a definition of the limits of the invention.

What is claimed is:

1. In a toy engine of the type embodying a tubular support, a plurality of collapsible

and expansible metallic vessels each having a movable end wall and a stationary end wall and mounted at intervals around the periphery of said support, means for admitting and exhausting a motive fluid to and from said vessels, and a crankshaft to be driven from said movable end walls, a device for transmitting the movement of each of said movable end walls to said crankshaft comprising a lever formed of sheet metal elements secured together and spread apart to form a bifurcated end, said lever being adapted to receive the thrust from said movable end wall, a lever support having a longitudinal portion and an arcuate portion, the latter portion having a curved surface conforming to a portion of the periphery of said tubular support and the longitudinal portion being pivotally secured between the furcations of the end of said lever, and a link connected at one end to the opposite end of said lever by the passage of the lever end through an opening in said link and the spreading of said lever elements, the other end of said link being adapted to be connected with said crank shaft, said lever, support and link being permanently secured together for installation as a unit after assembly of said vessels and tubular support, the arcuate portions of said lever supports surrounding said tubular support and being removably secured to one another when in installed position.

2. A toy engine comprising a tubular support provided at intervals therearound with a plurality of outwardly extending tubular bosses the passages of which communicate with the interior of the support, a plurality of expansible and collapsible metallic vessels each having a movable end wall and a fixed end wall, each of said fixed end walls being provided with a tubular extension threaded to one of said tubular bosses, the threaded engagement between said extensions and bosses constituting the sole support for said metallic vessels, a crankshaft rotatable in the tubular support and having means controlling the admission and exhaust of motive fluid to and from the vessels respectively through the tubular support and bosses and said tubular extensions, and power transmitting devices operatively associated with the movable end walls of the vessels and the crank of said shaft.

In testimony whereof I have signed this specification.

JEAN V. GIESLER.