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(54) ENGINE
(54) MACHINE MOTRICE

(57) Abstract:

This invention relates to the construction of engines.

Opposed-piston engines are already known of a type comprising a pair of cylinders in two parallel lines, two pistons in each line reciprocating in them, two cranks allotted to the respective pairs of pistons, and main connecting-rods each such rod operatively connecting the piston that is at one end of each line with one of the cranks aforesaid; the cranks have angular advance one in relation to the other and the pistons in each cylinder move in opposite directions therein, because, between the piston appropriated to each crank as aforesaid in one cylinder and that one of the pistons in the other cylinder which is not so directly crank-controlled, there is a diagonal cross-connection. Examples of engines of this type may be found in the specifications of prior British Letters Patent No.6102 of 1909(Fullagar) and 130767 (Cammell Laird & Co.Ltd. & ors.).

The diagonal cross-connection aforesaid has been rigidly connected at its opposite ends to the respective pistons by way of cross-heads, the lower cross-head in such cases having served as the main cross-head, that is to say as the cross-head to which the main connecting-rod has been connected.

Out of this construction difficulties have arisen. For example, the cross-head shoes or bearing surfaces of the main cross-heads having had to take not only the thrust in one plane due to the obliquity of the main connecting-rod, but also the diagonal thrust in another plane at right angles to the former due to the diagonal cross-connection aforesaid, have been subjected to wear upon two faces at right angles to each other. For this reason the said faces have been flat and as they have been formed upon parts of the same main cross-head, it has been difficult to maintain the latter in the perfect alignment in relation to the cylinder axis which is so essential in practice. The cross-head faces

taking the thrust due to the obliquity of the main connecting-rods have moreover had to be placed far apart in order to accommodate in between them on the same cross-head the attachment of the diagonal cross-connections aforesaid to that cross-head. This has resulted in a cross-head whose dimensions from front to back have been so great that its linear expansion when it became hot was considerable, thereby necessitating considerable working clearance between the aforesaid cross-head faces and the contiguous guide faces which have been rubbed thereby, otherwise such expansion from front to back could not have been accommodated.

Moreover, the said diagonal cross-connections have not only heretofore been rigidly attached by their upper and lower ends to the pistons, but they have been duplicated, one extending down the front of the engine and the other opposite to it down the back, and they have not each been arranged at the same distance from the fore-and-aft plane containing the axes of the four pistons. Consequently any elongation of the two rods which may have occurred has brought about, because of the lack of symmetry in their disposition and sometimes because of differences in the material of which they are made, a slewing of the main cross-heads, and therefore the cross-head and guide wearing-surfaces have worn into a curved form instead of remaining flat.

Moreover, engines of the type above defined have lacked accessibility so far as access to the main cross-heads and the connecting-rod bearings is concerned, owing to the fact that the columns forming supports for the cylinders have been made to afford guiding surfaces not only for the shoes bearing the thrust from the diagonal cross-connections aforesaid but also for the main cross-head and therefore have been set no further apart from one another than are the axes of the pairs of pistons.

The object of the present invention is to overcome these objections. According to the present invention the diagonal-

cross-connection aforesaid is not rigid, nor is it rigidly joined to the pistons, but is a jointed linkage comprising what are hereinafter termed "first" and "second" links, which links may individually be of twin construction, the first link in the plane of and approximately parallel with the axis of one of the pistons and jointed to that piston, the second link being jointed to the first link and the other piston. This jointed linkage is combined with a guiding device which constrains the joint connecting the first and second links to move in a line that is parallel to the piston-strokes, when it reciprocates with the pistons. This guiding device is quite distinct from the guides for the main cross-head. A linkage thus arranged and guided cannot impart to the main cross-head any side thrust arising out of the angularity of the diagonal link (the second link), such thrust being intercepted by the guiding device aforesaid. Thus the main cross-head is subjected only to wear of such kind as that which comes upon it by reason of the angularity of the main connecting-rod, thrust from the linkage being only a negligible amount or else being balanced as hereinafter described, and being in either case received on the vertical faces on which the ordinary horizontal resultant of the angular thrust of the main connecting-rod is exerted and not, as in previously-known constructions, giving another horizontal resultant at an angle to the former.

Preferably the joints which are employed to connect the linkage with the pistons are spherical whilst the joint which connects the first and second links to one another can be either hinged, or spherical. If it be hinged it should be so constrained that whilst it is compelled to move in its reciprocation with the pistons, in a line parallel thereto, it can shift laterally of such a line, into a new one parallel with it, should the cross-head arms or the linkage or both alter slightly in length,

or should the beam referred to in the next paragraph alter in effective length.

When the second link aforesaid is of twin construction it can be combined with a beam pivoted to the piston to which said second link is connected, the beam-pivot having an axis transverse to that of said piston, and the beam having at its ends spherical bearings constituting parts of the pivotal connection of the second link with the piston. In such a case, any difference in elongation between the two sides of a twin link or of the companion link to which it is connected, merely results in slightly tilting the beam about the beam-pivot and there can be no tendency to any slewing of the main cross-heads.

The arms which project from the main cross-heads and form part of the pivotal connection of the first link aforesaid to the piston corresponding with a cross-head, are long arms, and therefore the slipper or other guides which constrain said main cross-head are according to this invention put nearer to the axial line of the corresponding piston than are the ends of the arms. Therefore, should any expansion of the cross-head take place it is only the expansion of that short portion of it which is between the axial line of the corresponding piston and the slipper or other guide, which need be dealt with. Any expansion of that part of the arm of the cross-head which extends beyond the guide has no effect upon the latter, and only slightly moves the linkage laterally, the joints of the linkage permitting such movement without restraint or inconvenience.

Where in the jointed linkage above referred to the second links are of twin construction, the opposite

sides of each link are made to be equidistant from the plane of the axis of the pistons, and one second link has its elements spaced apart from one another widely enough to permit the companion twin link to work in the space thus afforded. Thereby even loading of the elements of the second link is secured. Such even loading has not been possible in the known type of engine in which the elements of the links have not been equidistant from the plane of the axis of the pistons. Where the links are twinned the parts thereof may be spread a little as in Figure 3 hereinafter described. Being equally spread, i.e. being symmetrically set relatively to the fore and aft plane containing the axis of the pairs of pistons, such side thrusts as this disposition of them causes upon the main cross-head cancel one another.

Further, in an engine of the type described the front columns which form supports for the plurality of cylinders in which the cross-connected pistons work, are set further apart from one another than are the axes of the pairs of pistons, and are combined with back columns and main cross-head guides supported by said back columns, and combined also with guides which constrain the joint connecting the aforesaid first and second links, which latter guides are at a level different from that of the main cross-head guides. This makes the two sets of guides independent of one another, enables the main cross-head to be kept in proper alignment with the piston to which it is appropriated, and also makes the main cross-heads and connecting-rod bearings easily accessible. The adjustment for wear of the guiding device which constrains

the joint connecting the first and second links is quite independent of any adjustment for wear of the main cross-head, for the latter is free from the need for any adjustment save that which may be due to wear brought about by (or as if by) the main connecting rods alone on the main cross-head shoes, which in such a construction as herein described will be in one direction only.

In the accompanying drawings, which illustrate one embodiment of this invention,

Figure 1 is a front elevation, partly in section, and with certain parts removed of an engine to which this invention is applied;

Figure 2 is a plan of a detail of Figure 1 and

Figure 3 is a side elevation, partly in section, and with certain parts removed, looking from the left-hand side of Figure 1.

Like reference characters indicate like parts throughout the drawings.

In the particular construction illustrated in the drawings, the bed-plate of the engine is shown at 10 and it is provided with front columns 11, and rear columns 12 to support the cylinders and other parts of the engine. As illustrated, the engine has four working cylinders indicated respectively at 13, 14, 15 and 16. These are arranged vertically and in pairs, 13, 14, constituting one pair, and 15, 16, constituting the other pair. It is only necessary to describe in detail one such pair of cylinders since the two pairs are duplicates of one another.

Considering then the two cylinders 13, 14, these are parallel with one another and each contains a

pair of pistons 17, 18 and 19, 20 reciprocating therein. The crank-shaft 21 has a separate crank-pin for each cylinder as shown at 22, 23, one of these cranks having an angular advance in respect to the other one. As illustrated, one crank is set 180° from the other. The crank-pins are coupled by connecting-rods 24, 25, respectively to the main cross-heads indicated as a whole by the reference 26, and these main cross-heads are coupled respectively to the lower pistons of the pairs (the two pistons in each cylinder being the pairs referred to,) by rods 27, 28 respectively, which are rigidly secured to the pistons.

The pair of cross-heads 26, are shown separately in plan, in Figure 2. Each cross-head comprises a central block 29 whereto the piston rod (27) is connected, and laterally-projecting pins 30 to receive the forked ends of the connecting-rod (24). This main cross-head is also provided with a bearing-face 31 of arcuate section to co-operate with a guide 32, see Figures 1 and 3, in the usual manner, this guide taking up the side thrust due to the obliquity of the main connecting-rod.

These main cross-heads 26 are moreover provided with arms projecting laterally from them at right-angles to the pins 30 as shown at 33, 34 respectively, and these arms are of such length that their ends 35, 36, (which for the purpose hereinafter described are preferably spherical) are situated at a greater distance from the axis of the pistons than is the slipper or bearing-surface 31. The arm 34 therefore projects through a slot formed in the guide 32 for the slipper 31.

As above-stated, it is the object of this

invention to provide an improved construction of the diagonal cross-connection between the pairs of pistons in two adjacent cylinders, that is to say, of the connections whereby the pistons 17 and 20 are caused to reciprocate in unison. and the other two pistons 19, 18. are also caused to reciprocate in unison with one another. A jointed linkage is used to connect the pistons and it comprises a "first link" 37 and a "second link" 38. The first link 37 is in pivotal connection with the piston 17 by its engagement at its lower end with the spherical end 35 of the arm 33 of the main cross-head aforesaid. As above-stated this main cross-head is rigidly secured to the piston, so that considered as a linkage the said first link 37 is pivotally connected to the piston 17. This joint will be hereinafter referred to as the "first pivotal connection" being the connection between a piston and its first link, and the joint is a spherical one. The link 37 is pivotally connected at its upper end to the lower end of the link 38, by a pivotal connection which is a pin joint or hinge and is indicated by the reference 39. The link 38 is connected at its upper end by a pivotal connection, which is preferably a spherical joint, as hereinafter described, to the piston 20; this joint is indicated by the reference character 40 in Figure 1.

It will be seen, therefore, that the linkage comprises a first link 37, a second link 38 and three pivotal connections, the first at the cross-head 26, the second between the two links at 39 and the third between the second link and its piston at 40.

The joint 39 which is a hinge or pin-joint

incorporates a sliding member 41 formed with main and auxiliary bearing-surfaces 42, 43, which slide on guides 44, 45, respectively. It will be seen that the guide 44, which takes the lateral thrust caused by tension in the link 38 and its oblique position relatively to its movement, is at right-angles to the plane of the guide 32, which takes the lateral thrust of the main connecting-rod 24: Moreover, it is located at a different level in the engine structure. The main guides 32 are supported on the main back columns 12 aforesaid, for example being made integral with portions thereof, as shown in Figure 3, and being supported as to their lower ends by a transverse horizontal beam extending between the back columns 12. The columns 11 and 12 are connected together at their upper ends by bridge-pieces, and the auxiliary guides 44 are supported from this bridge-piece in any desired manner, being for example, formed thereon.

The front columns 11 are spaced apart as shown in Figure 1, further from one another than are the axes of the pairs of pistons whose cylinders they support. By this construction, therefore, the two sets of guides 32, 44, with their co-operating slippers 31, 42, are separated and independent of one another, and easily accessible. Any adjustment for wear between the slipper 42 and its guide 44 is independent of the adjustment of the main cross-head 26 since such adjustment of the slipper 42 can be taken up on the spherical joint 36 at the lower end of the link 37 without disturbing the alignment of the main cross-head 26 with the piston 17 to which it is appropriated.

Further, it will be seen, as above stated, that any thermal expansion of the outer end of the arm

34 of the cross-head 26 does not affect the location of the cross-head with respect to its guide 32, since that location can be varied only by the expansion of the comparatively short length between the axis of the cross-head and the slipper 32. The expansion of the outer end of the arm 34 merely causes the first link 37 to be thrown out of alignment, and such tilting of the links is accommodated by the spherical joint 36.

It is preferred to construct the jointed linkages hereinbefore described so that each link is of twin formation, the two elements of each link lying at opposite sides of the piston. That is to say, in Figure 1, one element of the first link 37 is on the front of the cylinder 13 and its companion element 37* is in a corresponding position behind the cylinder. That is to say they are situated in the plane of the axis of the piston to which they are appropriated and at opposite sides of that piston. This is shown most clearly in Figure 3. The construction of linkage illustrated in Figure 1 as applied to the cylinder 13 is duplicated and it is for this reason that the cross-head 26 shown in Figure 2 is provided with the two laterally-projecting arms 33,34. It is to be understood, however, that the slipper 31 is not an element of the special linkage and it therefore is not duplicated. This slipper accomplishes the ordinary functions of a main cross-head which is to accommodate the lateral thrust due to the obliquity of the main connecting-rod.

The second link 38 of the linkage is also duplicated as shown in Figure 3 at 38, 38* and the connection of this twin second link, at its upper end to its piston

is shown most clearly in Figure 3 in the case of the piston 18. It will be appreciated that the twin links 38, 38* are connected to the piston 20, but their connection lies behind the piston 18 in Figure 3 and is thereby concealed. The connection of the corresponding twin elements 50, 51 are however shown. Each of these links is coupled by a spherical joint 52 to a beam 53 which is pivoted to the piston by a pivot having an axis transverse to that of the piston. The pivot pin is shown at 54, being in this construction of engine horizontal and lying in the plane of the axes of two co-operating cylinders. The pivot-pin itself is mounted on, or secured to a slipper 56 which slides upon a guide face 57. This slipper 56 is rigidly secured to its appropriate piston, and the guide 57 takes up the lateral thrust due to the obliquity of the second link. By this construction any difference in elongation between the two elements or a twin link, from any cause, merely results in slightly tilting the beam 53 on its pivot. This tilting movement is fully accommodated by the spherical joints 52 and imparts no slewing or twisting tendency to the main cross-head, as has occurred in previous constructions of cross-connected engines of this type.

The two elements 38, 38* of the "second link" above-described are similarly connected to a beam 55. The two beams 53, 55, are each supported centrally on their slippers and pistons, or in other words, the two elements of a "second link" are equidistant from the axis of the piston to which they are connected. Even loading of the two elements of each second link is thereby secured, this not having been possible in engines

heretofore constructed. It will be seen in Figure 1 that on each side of the engine, that is to say the front and back, the elements of the second links, for example 38, 50, cross one another and to accommodate them, one of the beams 55 is made longer than the other beam 53. Preferably the lateral spacing apart of the hinge joints 39 at their lower ends, as shown in Figure 3, is such that each of the elements 38, 50 is equally inclined to the vertical, but on opposite sides thereof. All the joints 39 with their slippers 42 on the front of the engine can therefore lie in one plane and similarly those at the back of the engine can all lie in one plane, such planes being parallel to the vertical plane containing the axes of all the cylinders.

It will be seen that with this construction the various slippers and their guides are all easily accessible. The main cross-heads 26 are directly accessible from the front of the engines between the front columns 11 which are spaced apart for this purpose, as above-described; similarly the slippers 42, 43, with their guides 44, 45 are also accesible, although for convenience they are covered by a detachable cover-plate 60 which is shown in position at the right-hand side of Figure 1. Finally, the top-most slippers 46 with their guides 47 are merely covered by a detachable cover 61 which is also shown in position on the right-hand side of Figure 1, and in Figure 3, this cover being slotted as at 62 so that the spherical ends of the beams 53, 55 can project through it. The result of this is that the three pivotal connections in the linkage are also readily accessible for inspection or adjustment.

CLAIMS

1. In an engine of the type described, the employment of a jointed linkage cross-connecting the two pistons which reciprocate in different lines and comprising "first" and "second" links (which links may individually be of twin construction) the "first link" being in the plane of and parallel (or virtually so) to the axis of one of the pistons and jointed to that piston, the "second link" being jointed to the first link and to the other piston, together with a guiding device which constrains the joint connecting the first and second links to move in a line that is parallel to the piston strokes when it reciprocates with the pistons.

2. A construction according to preceding claiming-clause No.1 with the joints spherical which are employed to connect the linkage with the pistons and with the joint hinged or spherical that connects the first and second links to one another, with or without a guiding device that when the hinged joint aforesaid is employed enables said joint to adjust itself across the direction of its reciprocation.

3. A construction according to preceding claiming-clause No.2 and comprising a "second link" which is of twin construction in combination with a beam which is pivoted to the piston to which said second link is connected, the beam pivot having an axis transverse to that of said piston and the beam having at its ends spherical bearings constituting parts of the pivotal connection of the "second link" with the piston.

4. In an engine of the type described, a main cross-head to which the little-end of a main connecting-rod is attached, arms projecting from said main cross-head and forming part of the pivotal connection of the "first link" aforesaid to the piston corresponding with that cross-head, and slipper or other guides which constrain said main cross-head, and are situated nearer, for the purpose described, to the axial line of the corresponding piston than are the said pivotal connections.

5. In an engine of the type described, front columns forming supports for the plurality of cylinders in which the cross-connected pistons work, the said front columns being set apart wider from one another than are the axes of the pairs of pistons, in combination with back columns, main cross-head guides supported by said back columns, and guides which constrain the joint connecting the aforesaid first and second links and are at a level different from that of the main cross-head guides.

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6. In an engine of the type described, the employment of two "second links" of twin construction in each of which the opposite sides of the link are equi-distant from the plane of the axis of the pistons, and one of which has its elements spaced apart from each other widely enough to permit the other twin link to work in the space thus afforded.

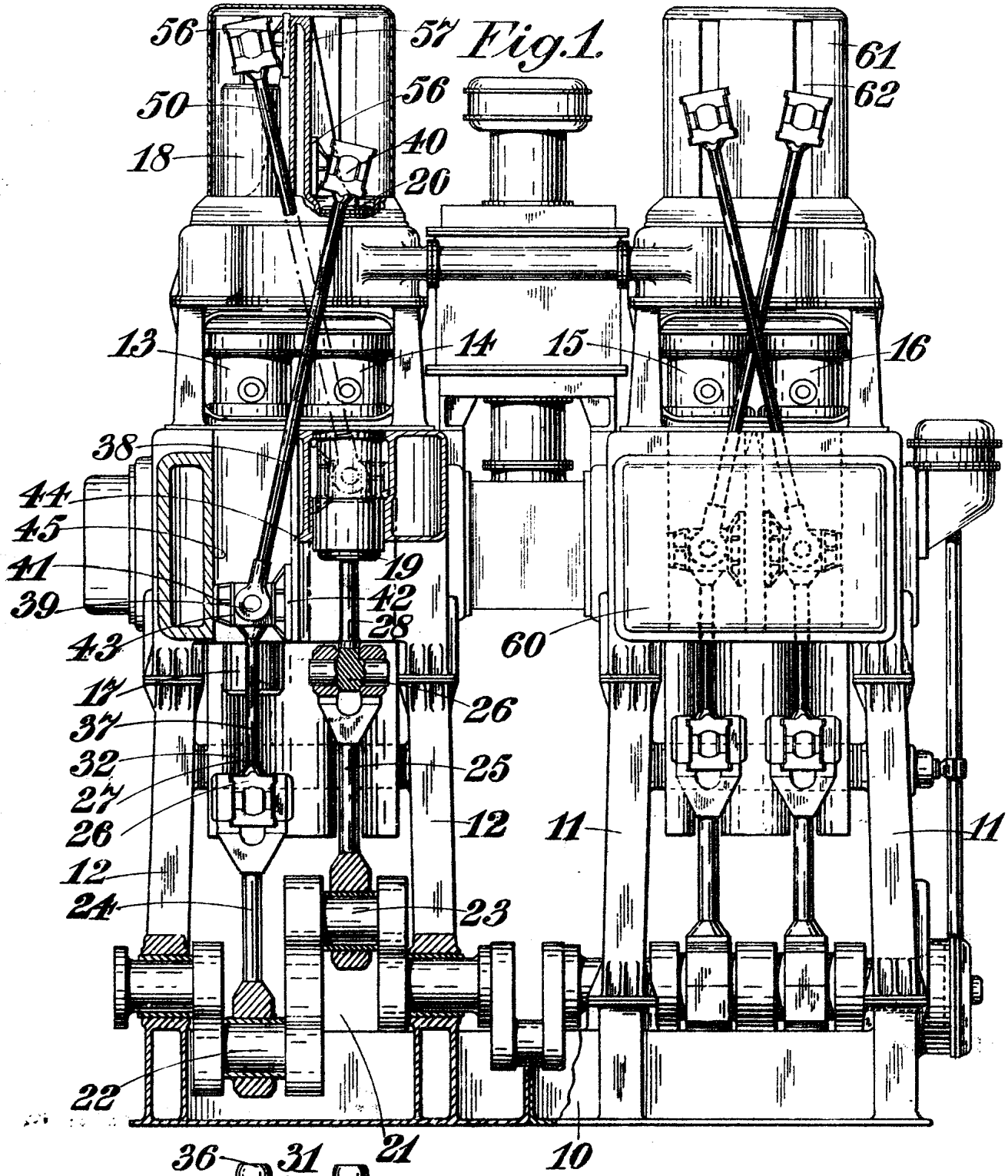

Fig. 1.

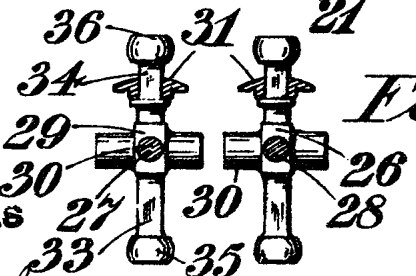

Fig. 2.

WITNESSES

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CERTIFIED TO BE THE DRAWINGS REFERRED TO IN THE SPECIFICATIONS HEREUNTO ANNEXED.

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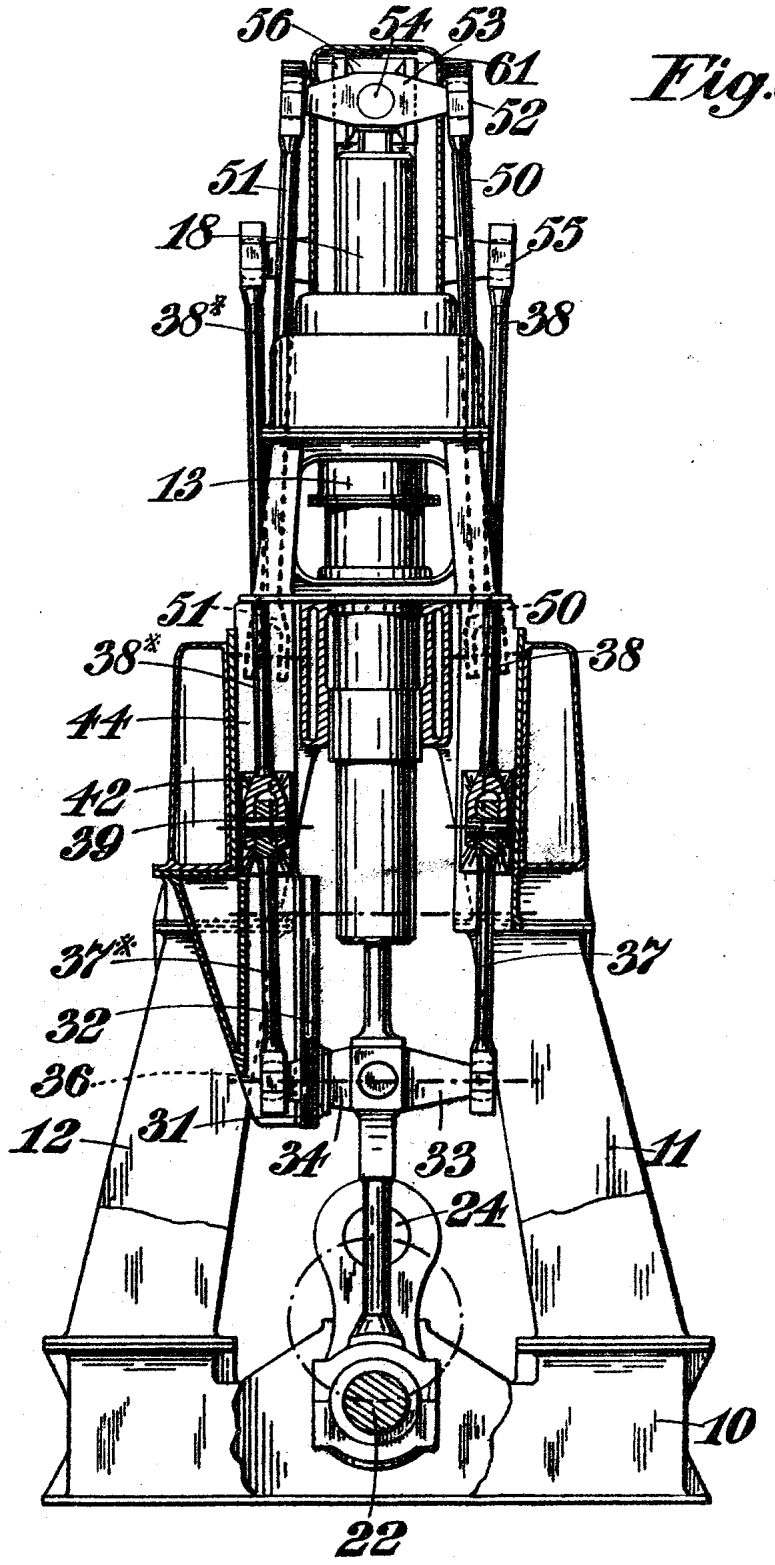

Fig.3.

WITNESSES

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