July 25, 1939. C. S. SARKAR 2,167,314

MEANS FOR CONVERTING RECIPROCATING INTO ROTARY MOTION

Filed Jan. 28, 1938 7 Sheets-Sheet 1

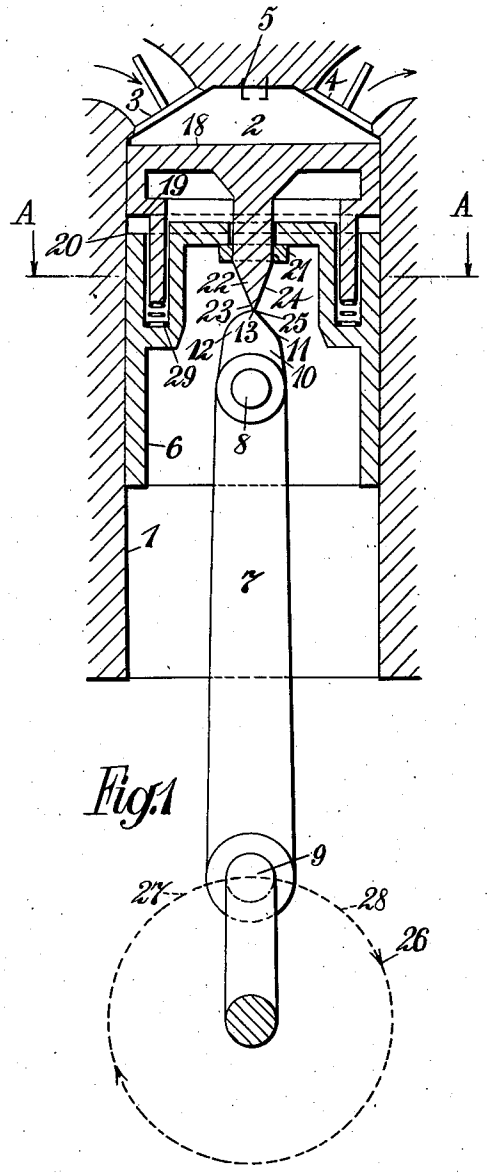


Fig. 1

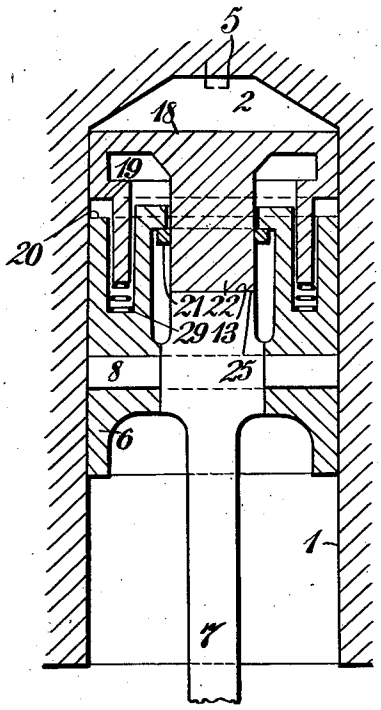


Fig. 2

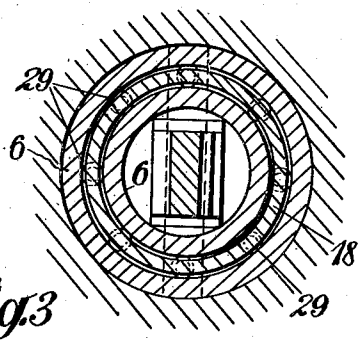


Fig. 3

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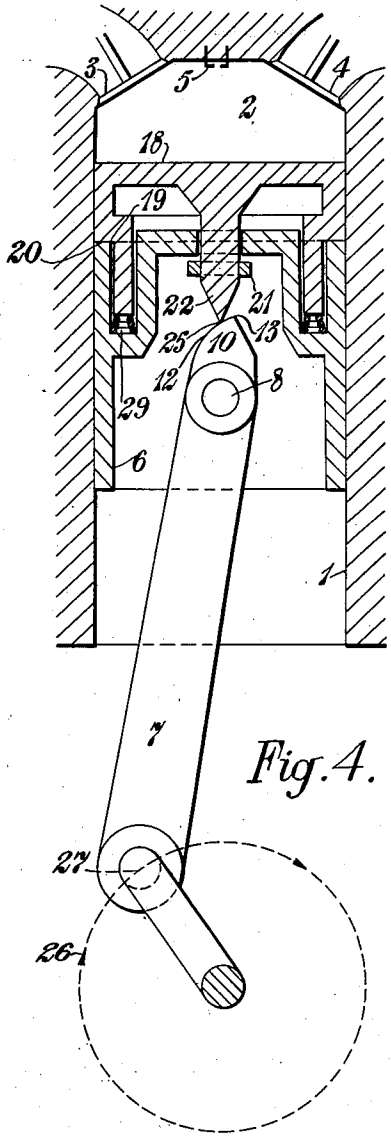


Fig. 4.

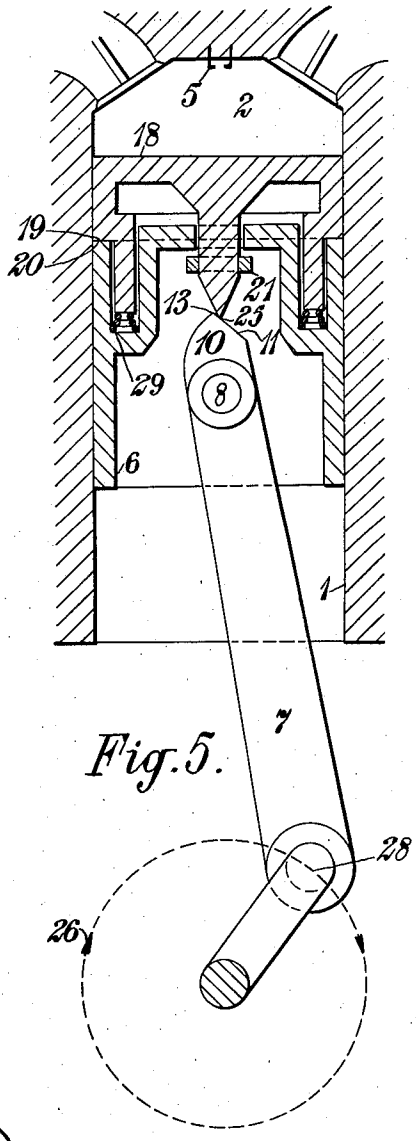


Fig. 5.

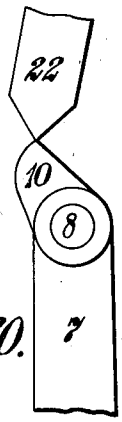


Fig. 20.

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MEANS FOR CONVERTING RECIPROCATING INTO ROTARY MOTION

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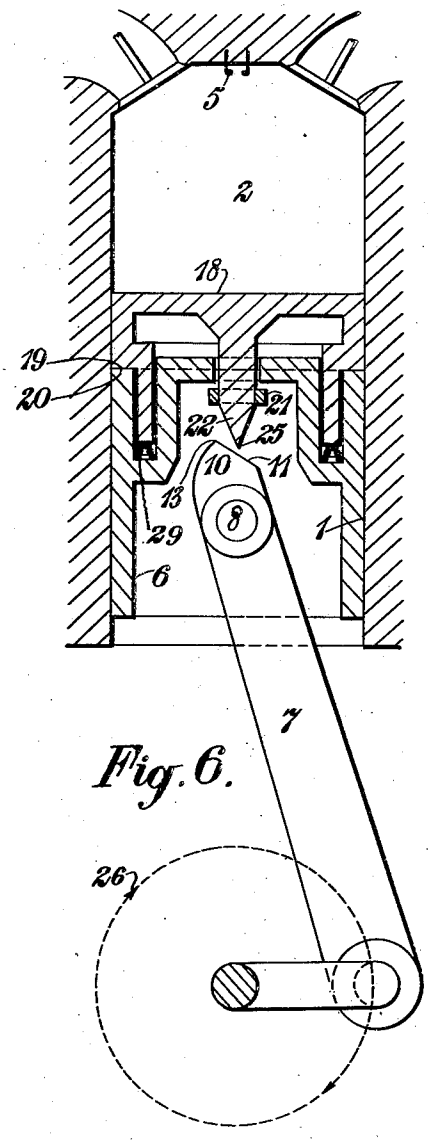


Fig. 6.

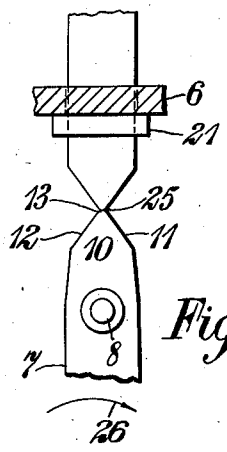


Fig. 7.

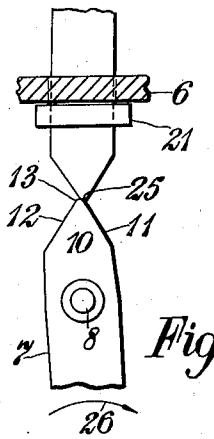


Fig. 8.

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MEANS FOR CONVERTING RECIPROCATING INTO ROTARY MOTION

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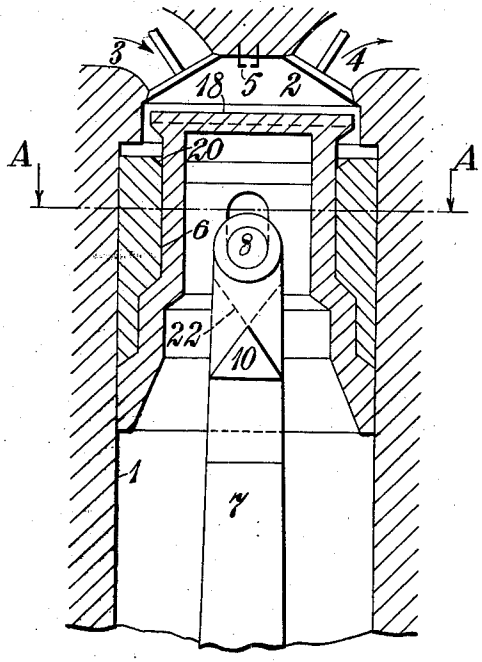


Fig. 9.

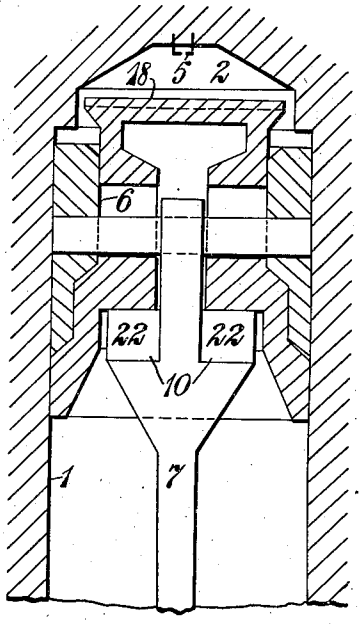


Fig. 10.

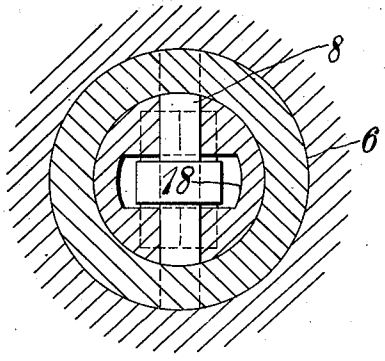


Fig. 11.

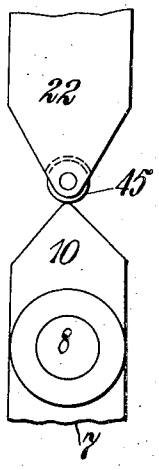


Fig. 23.

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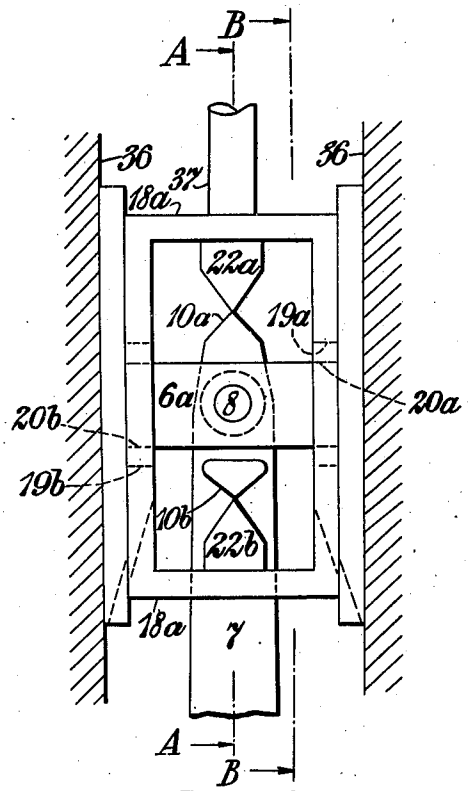


Fig. 12.

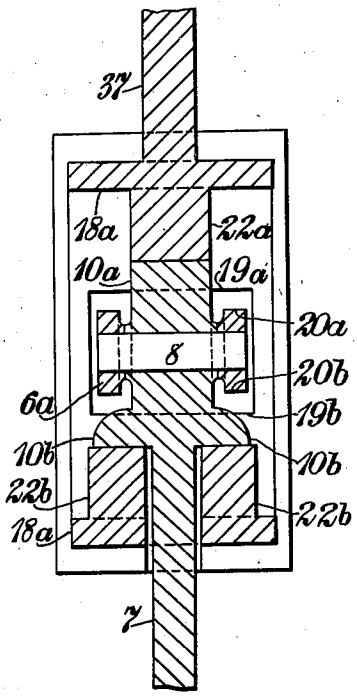


Fig. 13.

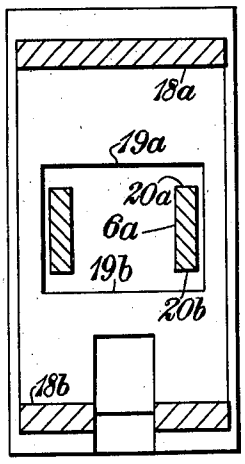


Fig. 14.

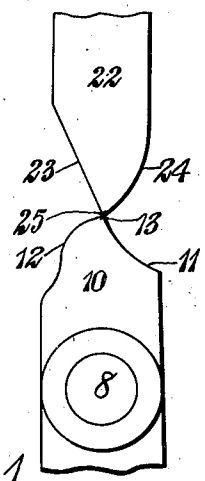


Fig. 21.

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By: Mascock Downing & Sebald Attys.

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MEANS FOR CONVERTING RECIPROCATING INTO ROTARY MOTION

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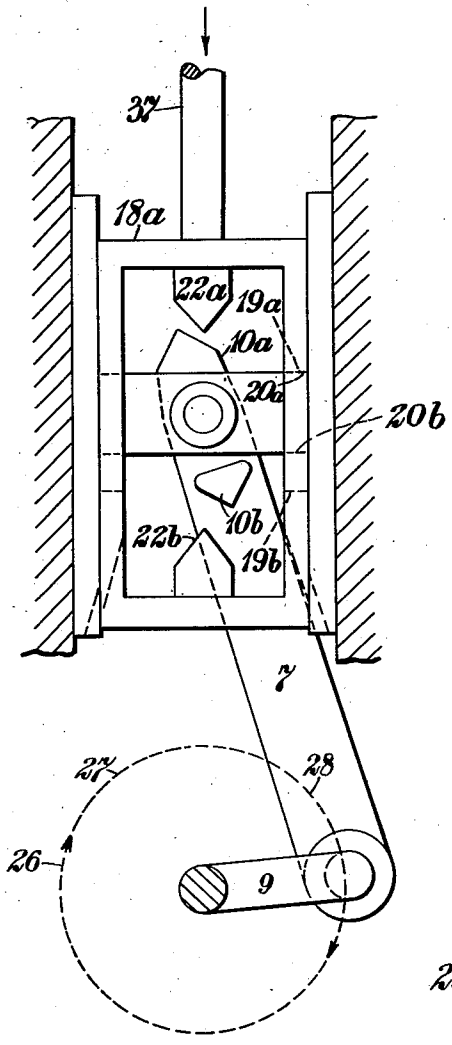


Fig. 15.

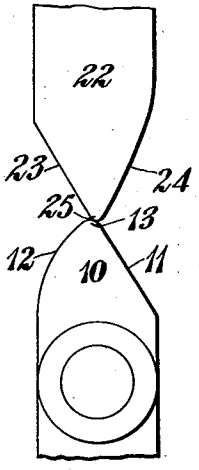


Fig. 22.

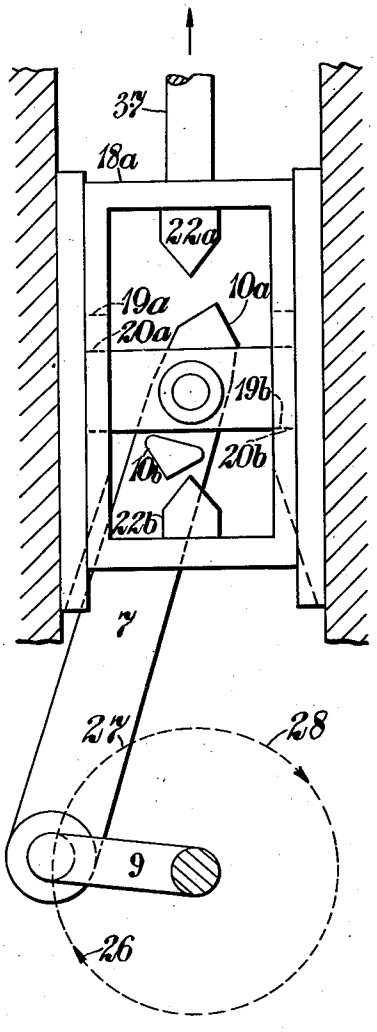


Fig. 16.

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July 25, 1939. C. S. SARKAR 2,167,314

MEANS FOR CONVERTING RECIPROCATING INTO ROTARY MOTION

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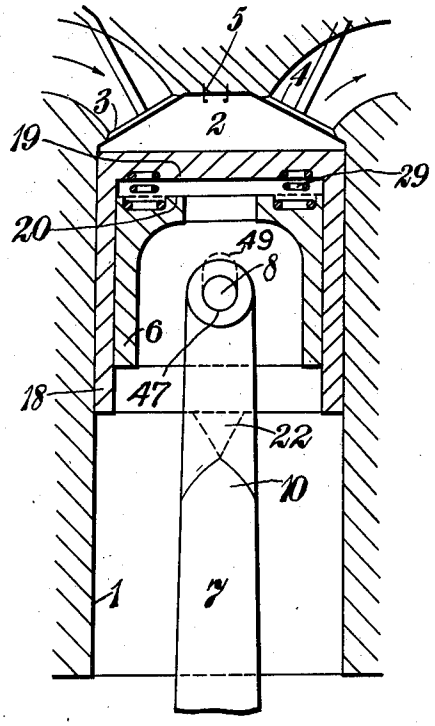


Fig. 24.

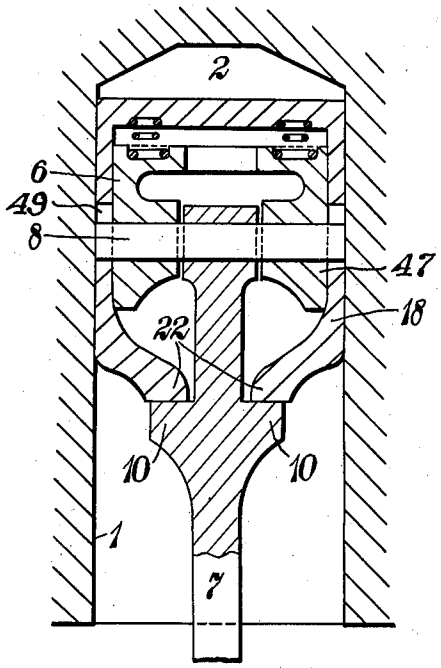


Fig. 25.

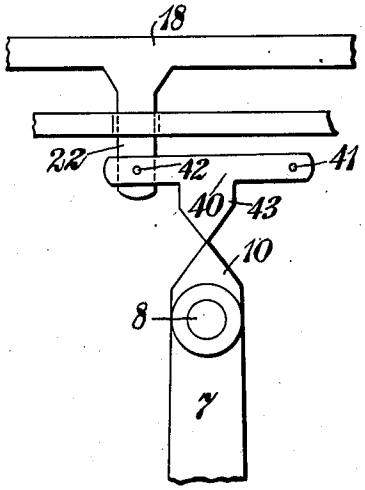


Fig. 17.

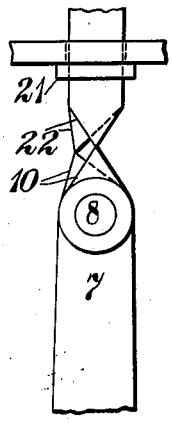


Fig. 18.

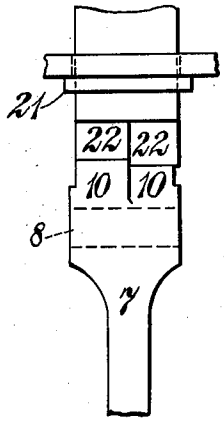


Fig. 19.

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Patented July 25, 1939 2,167,314

UNITED STATES PATENT OFFICE

2,167,314

MEANS FOR CONVERTING RECIPROCATING INTO ROTARY MOTION

Chandra Sekhar Sarkar, Calcutta, India

Application January 28, 1938, Serial No. 187,541
In Great Britain March 8, 1937

5 Claims. (Cl. 74—36)

This invention relates to improved means for converting reciprocating into rotary motion, particularly in piston engines and compressors.

Heretofore it has been found that the pressure of the working fluid on the piston is a maximum when the piston is at or near the dead centre when the turning effort on the crank is zero or very low and the pressure of the fluid decreases due to its expansion as the piston moves forward from the dead centre and the turning effort increases, due to the increase of angularity of the connecting rod. Thus the higher pressure of the fluid is not utilised in useful work for turning the crank but used in undesirable work such as increase in strain and vibration as well as roughness and inefficiency of the engine or compressor. The advent of the tubulent combustion chamber has caused the development of engine roughness. Similar defects occur when the crank approaches dead centre during the compression stroke of an internal combustion engine or a compressor. Extra pressure is exerted on the side of the cylinder by the piston when near the middle of its stroke due to the angularity of the connecting rod thus causing wear about the middle portion only of the cylinder, also there is no turning effort on the crank when it is at dead centre.

The present invention has for its main object to obviate or decrease or tend to decrease the afore-mentioned defect or defects and to decrease the chance of a break-down and the weight of the engine.

Another of the objects of the invention is to provide an improved engine whereby near the dead centre position of the engine the angular motion given by the crank to the connecting rod during the compression stroke will compress further the working fluid in the cylinder, and the pressure exerted by the working fluid in the cylinder during the expansion stroke as the crank is moving from the dead centre gives additional circular or turning effort to the crank through the connecting rod than has been done previously. A further object is to give angular movement to the crank through its connecting rod when it is at the dead centre.

A further object of the invention is the provision of a spring or springs, compressed gas and the like to maintain the pistons or cross-heads apart when the pressure of the working fluid in the cylinder of the engine is low or falls below a predetermined value.

In addition to the main piston or cross-head another piston or cross-head which may be described as an auxiliary piston or cross-head, is provided with a projecting element or elements operating wholly or partly in or outside of the main piston or cross-head. The main piston is connected with the connecting rod by the gudgeon pin as usual, and the connecting rod is also provided with a projecting element or elements; the auxiliary cross-head is connected with the piston rod. Projecting elements of the auxiliary piston or cross-head and the connecting rod are adapted to come into co-operation near the dead centre, after which the solid portions or shoulders of the auxiliary piston or cross-head and the main piston or cross-head come into contact and operate as one main piston or cross-head.

Near the end of the compression stroke of an engine the circular or angular motion of the connecting rod pushes the auxiliary piston or cross-head in the main piston or cross-head towards its end through its projecting element, and during the expansion stroke the pressure of the working fluid pushes the auxiliary piston or cross-head so that forward motion of the projecting element of the auxiliary piston or cross-head gives a turning effort on the crank through the projecting element of the connecting rod, during such operation the main piston or main cross-head will function as an ordinary piston or cross-head. Extra side pressure is exerted on the cylinder (by the main piston and due to the auxiliary piston and gudgeon or piston pin of the connecting rod) which causes it to wear at this portion.

If the apex of the auxiliary piston or cross-head should happen to come in contact with the side instead of with the apex of the projecting element of the connecting rod at the dead centre position, the pressure on the auxiliary piston or cross-head will still give an angular or circular motion to the connecting rod through its projecting element even when the engine starts from rest position.

Spring means or compressed gas and the like between two pistons or cross-heads may be arranged in such a manner that the auxiliary piston or cross-head is pushed away from the main piston or cross-head as the pressure of the working fluid in the cylinder falls below a predetermined value so that the projecting elements of the pistons or cross-head will be inoperative except at the end of compression stroke and beginning of the expansion stroke. There will be a further advantage of storing a part of the high pressure of the working fluid by the spring when the crank is at a disadvantageous position: this

added pressure being utilised or given up when the crank is at an advantageous position of the expansion stroke.

The invention is illustrated diagrammatically by way of example in the accompanying drawings which show some of the forms it can adopt.

For simplicity in the drawings only the essential features of the invention have been introduced but it will be understood that provision for suitable cooling of the engine, piston rings, lubrication, construction and manufacturing details and the like which form no part of this invention may be made as is customary and some members, viz. the auxiliary piston 18 of Figure 9 and auxiliary cross-head 18a of Figure 12, are shown in the drawings as one piece but this may be made in parts and bolted together as one piece or unit after they have been assembled or fitted and several features individually described may be adopted in one machine.

In the drawings:

Figure 1 illustrates a cross-sectional elevation of a petrol engine when the piston is at the dead centre in which the projecting element of the auxiliary piston co-operates with the projecting element at the end of the connecting rod. The connecting rod is connected with the main piston by a gudgeon pin and springs are provided between the two pistons.

Figure 2 is a cross-sectional side elevation of the arrangement shown in Figure 1.

Figure 3 is a sectional plan taken on the line A—A of Figure 1.

Figures 4, 5 and 6 show the same view as Figure 1 but with the piston or crank at a different position.

Figure 7 shows part of the same view as in Figure 1 with the apex of the projecting element of the auxiliary piston in contact with the apex of the projecting element of the connecting rod at the dead centre.

Figure 8 shows the same view as Figure 7, but with the apex of the auxiliary piston in contact with the side of the projecting element of the connecting rod at the dead centre.

Figure 9 shows in cross-sectional elevation a further form of a petrol engine of Figure 1 in which two projecting elements on the side of the connecting rod are operated by two projecting elements of the auxiliary piston, the face of the auxiliary piston covering only the part of the face of the main piston.

Figure 10 shows a sectional side elevation of the arrangement shown in Figure 9.

Figure 11 shows a sectional plan taken on the line A—A of Figure 9.

Figure 12 illustrates a cross-sectional elevation of a cross-head of a double acting engine when the piston is at the dead centre, in which the projecting elements of the auxiliary cross-head connected with the piston rod of an engine operate the projecting elements of the connecting rod. The connecting rod is connected with the main cross-head by a gudgeon pin as usual; there being two sets of projecting elements serving in one position to contact together in the double acting engine.

Figure 13 shows a cross-sectional side elevation taken on line A—A of Figure 12.

Figure 14 shows a cross-sectional side elevation taken on line B—B of Figure 12.

Figures 15 and 16 show the same view as Figure 12 but with the piston or crank at a different position, and

Figures 17 to 23 show details of other modifications.

Figure 24 shows in cross-sectional elevation a modified form of a petrol engine of Figure 1, in which two projecting elements on the side of the connecting rod are operated by two projecting elements of the auxiliary piston which itself is outside of the main piston.

Figure 25 shows a sectional side elevation of the arrangement shown in Figure 24.

Throughout all the figures, the same parts are denoted by similar numerals.

Referring to Figure 1 the cylinder 1 of an internal combustion engine is provided at its upper end with a combustion chamber 2 having the usual inlet valve 3, exhaust valve 4 and sparking plug 5. The main piston 6 which is shown at dead centre position reciprocates inside the cylinder 1, and is connected with the connecting rod 7 by a gudgeon or piston pin 8. The connecting rod 7 is connected with the crank 9 and provided at its end with projecting portion 10 having two sloping sides 11 and 12 which meet at apex 13. An auxiliary piston 18 can reciprocate in the main piston 6 and its movement in the main piston 6 is prevented or limited by a solid portion or shoulder 19 of the auxiliary piston 18 and the solid portion or shoulder 20 of the main piston 6 on one side and by a collar 21 on the other side made rigid with the projecting part 22 of the auxiliary piston 18 by a suitable pin or screw. The projecting portion 22 comprises two sloping sides 23 and 24 which meet at apex 25. Eight springs 29 of suitable strength are provided to push the auxiliary piston 18 when the pressure of gas in the cylinder falls below a certain value. The arrow 26 indicates the direction of the rotation of the crank 9 and certain angular positions of the crank, say 30°, to and from the dead centre of the crank 9 at which the projecting parts 22 and 10 come in operation, are indicated by 27 and 28.

During the compression stroke when the crank 9 approaches the position 27, the main and auxiliary pistons 6 and 18 move upwardly and the pressure of the compressed gas on the auxiliary piston 18, which at this position is more than the strength of the springs 29, pushes the auxiliary piston 18 downwardly and the shoulders 19 and 20 of the auxiliary piston 18 and main piston 6 come in contact with each other, and although the projecting portion 22 with its collar 21 has moved towards the piston pin 8 owing to the angularity of the connecting rod 7 the side 12 of the projecting portion 10 of the connecting rod 7 is not in actual contact with projecting portion 22. As the obliquity of connecting rod 7 decreases the side 12 (of the projecting portion 10 of the connecting rod 7) comes in contact with the apex 25 (of the projecting portion 22 of the auxiliary piston 18) when it reaches the position 27 (shown in Figure 4). As the crank 9 moves further toward dead centre, the angular motion of side 12 of the projecting part 10 of the connecting rod 7 pushes up the auxiliary piston 18, through the apex 25 of the projecting part 22. Consequently at dead centre position of the crank, (shown in Figure 1) the apex 25 (of the projecting part 22 of the auxiliary piston 18) after sliding over the side 12 (of the projecting part 10 of the connecting rod 7) has come in contact with its apex 13, and the solid part or shoulder 19 (of the auxiliary piston 18) and the shoulder 20 (of the main piston 6) have separated to the maximum and the collar 21 of the projecting

part 22 of the auxiliary piston 18 has come in contact with the upper portion of the main piston 6. At this position the explosion in the combustion chamber 2 occurs and the pressure of the gas on the auxiliary piston 18 pushes the apex 25 of its projecting portion 22 causing it to slide on the side 11 of the projecting portion 10 thereby giving the connecting rod 7 a turning effect towards the direction shown by the arrow 26. As the crank moves forward from dead centre the angularity of the connecting rod 7 increases and when the crank 9 arrives at position 28 (shown in Figure 5) the projecting portions 10 and 22 are just out of contact with each other. The pressure of the gas on the auxiliary piston 18 will now push the main piston 6 through their solid portions or shoulders 19 and 20 which are now in contact and the two pistons will act as one piston without any relative motion between them. As the crank moves further away from dead centre position the shoulders 19 and 20 are still in contact with each other and the auxiliary piston 18 and the main piston 6 act as an ordinary piston and due to the increased obliquity of the connecting rod its projecting portion 22 is out of contact with the projecting portion 10 of the auxiliary piston 18 (shown in Figure 6). This will continue up to near the end of bottom dead centre when in similar manner the projecting parts 10 and 22 again come in operation.

The projecting parts come in operation when the crank is near the (top and bottom) dead centre, which takes place four times at each complete cycle of a four stroke petrol engine. There is not much advantage of these projecting parts coming into operation except near the top dead centre of the crank at the end of compression stroke and beginning of the expansion stroke when the pressure of the gas in the cylinder is high. This is done by the use of springs 29 of suitable strength which keep the pistons separated when the pressure of the gas on the piston is low near the other dead centre positions thus preventing the projecting parts (except their apexes at the dead centre) coming in contact with each other and consequently preventing tnem coming into operation.

At the dead centre at the beginning of the expansion stroke the apex 25 of the projecting part 22 of the auxiliary piston 18 is in contact with the apex 13 of the projecting part 10 of the connecting rod 7, as shown in Figure 1 and in enlarged scale in Figure 7; the pressure of the gas on the auxiliary piston 18 at the dead centre and at the beginning of the expansion stroke does not give any angular or circular motion to the connecting rod and it is possible that when the engine is at rest the apex 25 may slide on the side 12 thus giving angular motion to the connecting rod towards the opposite direction of the arrow 26. If the apex 13 only and not the connecting rod is arranged to have an offset position as in Figure 8 the pressure of the gas at the dead centre on the auxiliary piston is sure to slide the apex 25 on the side 11 thus giving the connecting rod an angular motion towards the direction shown by the arrow 26 and it will have no chance of sliding on the side 12 even when the engine is to start from rest position; thus giving a circular motion to the connecting rod thereby to the crank at dead centre, which is not possible with an ordinary connecting rod, piston or cross-head. This effect may also be obtained by arranging the apex 25 in the offset position instead of apex 13.

Arrangements in Figures 9, 10 and 11 show modifications of the arrangement shown in Figure 1. The main alterations are the provision of two projecting parts 10 at the side of the connecting rod 7 instead of one projecting part 10 at the top of the connecting rod, which parts to operate with two projecting parts 22 of the auxiliary piston 18; also the area of the face of the auxiliary piston 18 is less than the area of the face of the main piston 6, so that near the dead centre position especially at the beginning of expansion stroke part of the pressure of the working fluid in the cylinder acts on the auxiliary piston 18 and part acts on the main piston 6, thus the effect of the pressure distributed on the faces of the two pistons is utilised if required when they are near dead centre position and after that the solid portion or shoulders 19 and 20 are in contact and the two pistons 18 and 6 act as one piston. Slots for the gudgeon pin 8 have been provided in the auxiliary piston 18 for its movement in the main piston 6, spring means between two pistons not being provided.

Figures 12, 13 and 14 show the arrangement of a double acting engine at dead centre in which projecting parts are provided not at the piston in the cylinder but at the piston rod, i. e. cross-head, outside the cylinder. The piston rod 37 of a double acting steam engine is rigidly fixed to the frame of the auxiliary cross-head 18*a*, which is provided with two sets of projecting parts—one projecting part 22*a* to co-operate with the projecting part 10*a* on the end of the connecting rod 7 when the piston rod 37 is on compression and another set of two indicated at 22*b* which co-operate with oppositely projecting parts 10*b* on the sides of the connecting rod 7 when the piston rod 37 is on tension. The auxiliary cross-head 18*a* reciprocates in the main cross-head 6*a* and its movement is restricted by the solid portions or shoulders 19*a* and 20*a* of the auxiliary cross-head 18*a* and the main cross-head 6*a* on one side and solid portions or shoulders 19*b* and 20*b* of the auxiliary cross-head 18*a* and the main cross-head 6*a* on the other side. The main cross-head 6*a* reciprocates in guides 36. The connecting rod 7 is connected with the main cross-head 6*a* by a gudgeon pin 8 in a usual way.

The Figure 12 shows the position of the connecting rod 7 and the position of the projecting parts 22*a*, 22*b*; and 10*a*, 10*b*; and shoulders 19*a*, 19*b* and 20*a*, 20*b* of the auxiliary cross-head 18*a* and the main cross-head 6*a* respectively when the connecting rod is at top or bottom dead centre, relative position of these parts being the same in top and in bottom dead centre.

Figure 15 shows the relative position of these parts when the crank 9 rotating in the direction of the arrow 26 has passed the position 28, i. e. the piston rod under compression has pushed down (by steam of the engine) after operating in a similar manner as in Figure 1 by means of the projecting part 10*a* of the connecting rod 7 and the projecting part 22*a* of the auxiliary cross-head 18*a* near the top dead centre, and is pushing down the main cross-head 6*a* through the solid portions or shoulders 19*a* and 20*a* of the auxiliary cross-head 18*a* and main cross-head 6*a* which are shown in contact.

Figure 16 shows the relative position of these parts when the crank rotating in the direction of the arrow 26 is approaching the position 27, i. e. the piston rod under tension being pushed up by the steam in the engine after operating in a similar manner (shown in Figure 15) by the pair of projecting parts 10*b* of the connecting

rod 7 through the pair of projecting parts 22b of the auxiliary cross-head 18a at the bottom dead centre, is pushing up the main cross-head 6a through the solid portions or shoulders 19b and 20b of the auxiliary cross-head 18a and the main cross-head 6a which are in contact. Figure 12 shows the relative position of shoulders and projecting parts of auxiliary cross-head and connecting rod when the connecting rod is at the top or bottom dead centre, their relative position being the same in both cases.

Although the invention has been particularly described in Figure 1 as applied to a single acting four stroke petrol engine and in Figure 12 as applied to a double acting steam engine, it will be apparent that it may be applied with advantage to other types of engines as well as compressors and different machinery such as printing presses or punching machines and the like. Two or more auxiliary pistons or cross-heads may be used for double acting. The projecting parts shown in the drawings may be of any shape and size and may operate indirectly through suitable mechanism or leverage, and they may be at any angle or position and their sides and apex may be of any shape. For example Figure 17 shows the projecting part 22 of the auxiliary piston 18 provided with the separate piece 40 which is pivoted by a pin 41 to the main piston and is operated through the pin 42 by the projecting part 22 of the auxiliary piston 18. The projecting part 43 of the piece 40 co-operates with the projecting part 10 of the connecting rod 7 due to the leverage of the point of application of parts 42 and 43. In Figure 18 two projecting parts 22 and 10 for auxiliary piston and connecting rod may be provided instead of one set as in Figure 1. Figure 19 is the side view of Figure 18. Figure 20 shows an arrangement where the projecting parts 22 and 10 are at an angle with the central line of the connecting rod, i. e. the central line of the engine. Figures 21 and 22 show the different projecting parts have sides 11, 12, 23 and 24 of differing angles, and curvature and shape of the end or apex 13 and 25 are also shown different. In Figure 23 a roller 45 is provided with the projecting part 22 of the auxiliary piston 18. It will be evident that the constructions for carrying out the invention are susceptible to many other modifications and improvements to suit particular requirements.

Referring to Figs. 24 and 25 the main piston 6 which is shown at dead centre position reciprocates inside the auxiliary piston 18. The main piston 6 is connected with the connecting rod 7 by a gudgeon or piston pin 8. The connecting rod 7 is connected with the crank and provided at its two sides with two projected portions 10. An auxiliary piston 18 reciprocates in the cylinder 1. The movement of the main piston 6 in the auxiliary piston 18 is prevented or limited by a solid portion or shoulder 20 of the main piston 6 and the solid portion shoulder 19 of the auxiliary piston 18, and on the other side by the piston pin 8 and the bottom part 47 of the oblong slot 49 on the auxiliary piston 18 for the piston pin 8. Springs 29 of suitable strength are provided to push the auxiliary piston 18 when the pressure of gas in the cylinder falls below a certain value. The auxiliary piston 18 is shown in the drawings as one piece but this may be made in parts and bolted together as one piece or unit after they have been assembled. At the dead centre position the pressure of the gas on the auxiliary piston 18 transmits the pressure on the projecting elements 10 of the crank 7 through its projecting elements 22. After that the solid portion 18 of the auxiliary piston 18 comes in contact with that of the solid portion 20 of the main piston 6, as in Fig. 1.

I claim:

1. In means for converting reciprocating into rotary motion embodying main and auxiliary reciprocating members constituting a two-part piston or cross-head, of a crank, a connecting rod interposed between the main reciprocating member and said crank and having at least one projecting element rigidly connected thereto, the auxiliary reciprocating member having at least one projecting element rigidly connected thereto, both the main and auxiliary reciprocating members having co-operating surfaces to allow said members to operate as one unit without relative motion between them during compression and expansion strokes except near dead centre, said projecting elements constituting separated extensions of the connecting rod and auxiliary reciprocating member and which are brought into operative engagement near the dead centre in a manner to exert additional effort to turn the crank over dead centre.

2. In means for converting reciprocating into rotary motion embodying a two-part piston, of a main piston, a crank, a connecting rod interposed between the main piston and the crank and having at least one element rigidly projecting therefrom, an auxiliary piston having at least one element rigidly projecting therefrom, said pistons having co-operating surfaces to allow them to operate as one unit during compression and expansion strokes except near dead centre, said projecting elements constituting separated extensions of the connecting rod and auxiliary piston and which are brought into operative engagement near the dead centre in a manner to exert additional effort to turn the crank over dead centre, and spring means between said pistons to act thereon as the obliquity of the connecting rod increases whereby said projecting elements become disengaged.

3. In means for converting reciprocating into rotary motion embodying a two-part piston, of a main piston, a crank, a connecting rod interposed between the main piston and the crank and having a plurality of elements rigidly projecting therefrom, an auxiliary piston having a plurality of elements projecting therefrom, said pistons having co-operating surfaces to allow them to operate as one unit without relative motion between said pistons during compression and expansion strokes except near dead centre, said projecting elements constituting separated extensions of the connecting rod and auxiliary piston and which are brought into operative engagement near the dead centre in a manner to exert additional effort to turn the crank over dead centre.

4. In means for converting reciprocating motion into rotary motion embodying a two-part cross-head, of a main cross-head, an auxiliary cross-head, a crank, a piston rod fixed to the auxiliary cross-head, a connecting rod interposed between the main cross-head and the crank having a plurality of elements rigidly projecting therefrom, said auxiliary cross-head having a plurality of elements rigidly projecting therefrom, said cross-heads having co-operating surfaces to allow them to operate as one unit without relative motion between them during compression and expansion strokes except near dead

centre, said projecting elements constituting separated extensions of the connecting rod and auxiliary cross-head and which are brought into operative engagement near the dead centre in a manner to exert additional effort to turn the crank over dead centre.

5. In means for converting reciprocating into rotary motion embodying main and auxiliary reciprocating members constituting a two-part piston or crosshead, of a crank, a connecting rod interposed between the main recipocating member and said crank having at least one projecting element rigidly connected thereto, the auxiliary reciprocating member having at least one projecting element rigidly connected thereto, both the main and auxiliary reciprocating members having co-operating surfaces to allow said members to operate as one unit during compression and expansion strokes except near dead centre, said projecting elements comprising different angular contactual surfaces constituting separated extensions of the connecting rod and auxiliary reciprocating member and which are brought into operative engagement near the dead centre in a manner to exert additional effort to turn the crank over dead centre.

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