

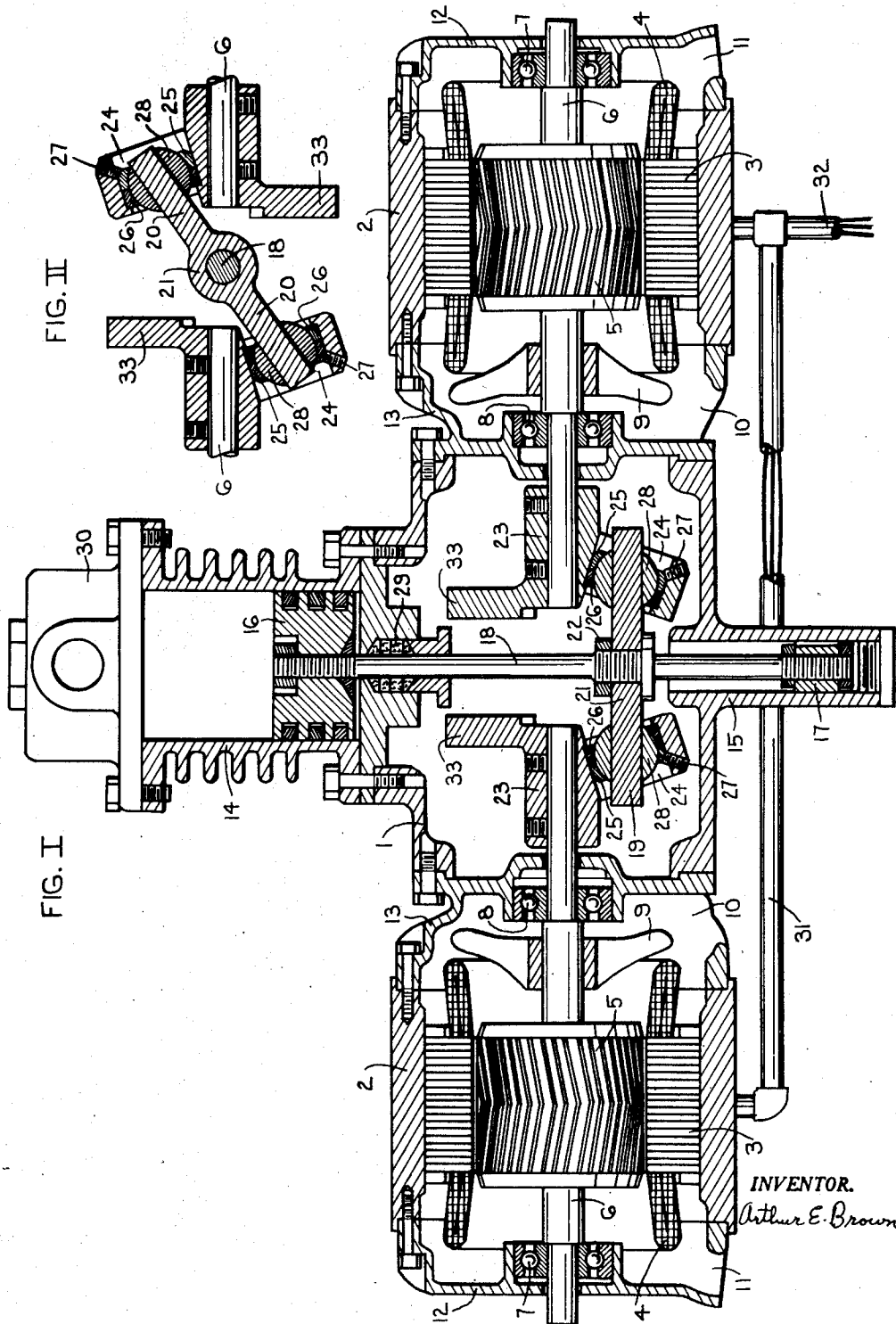
Dec. 28, 1954

A. E. BROWN
ELECTRICAL POWER UNIT

2,698,394

Filed June 6, 1950

3 Sheets-Sheet 1



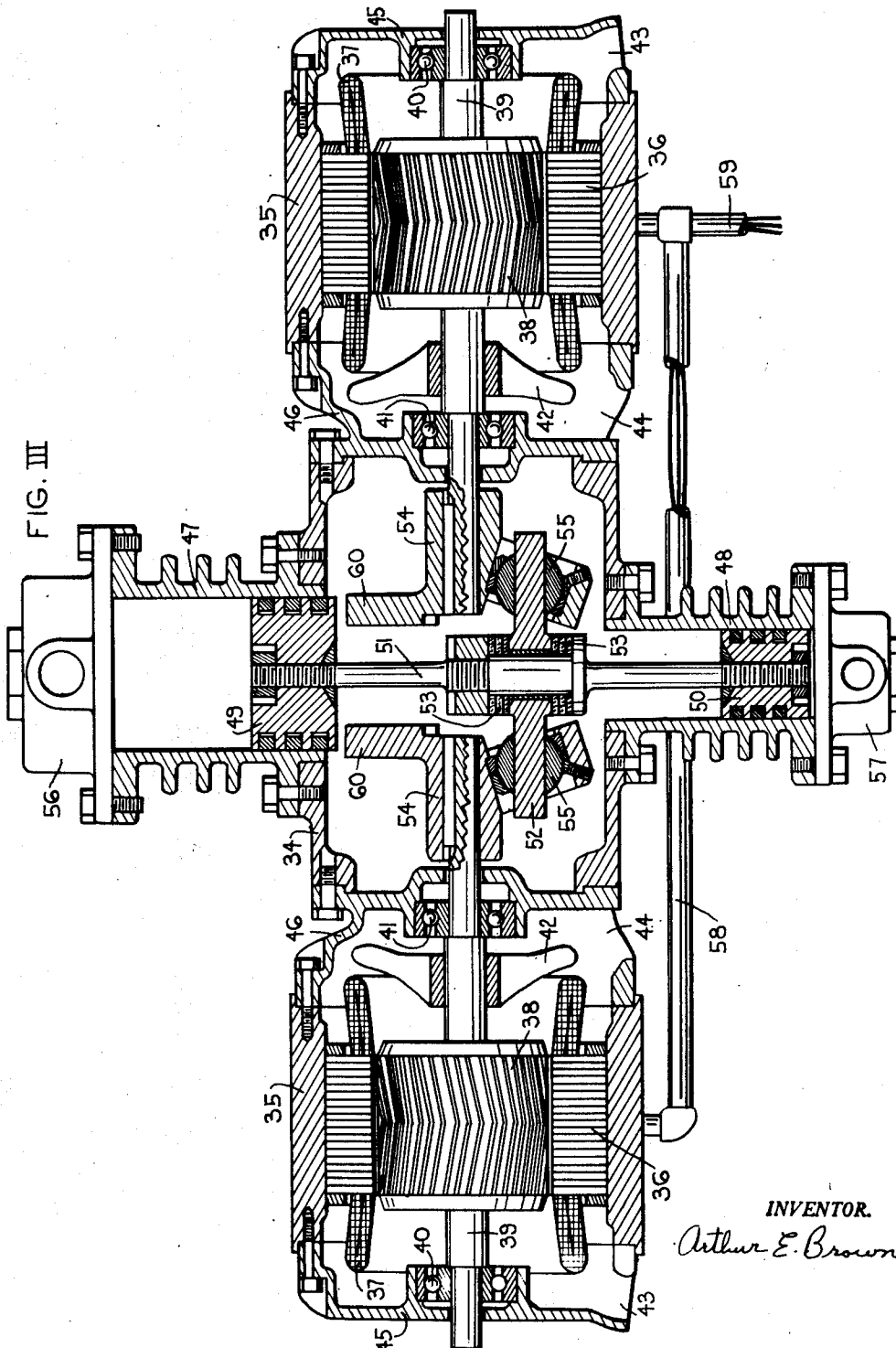
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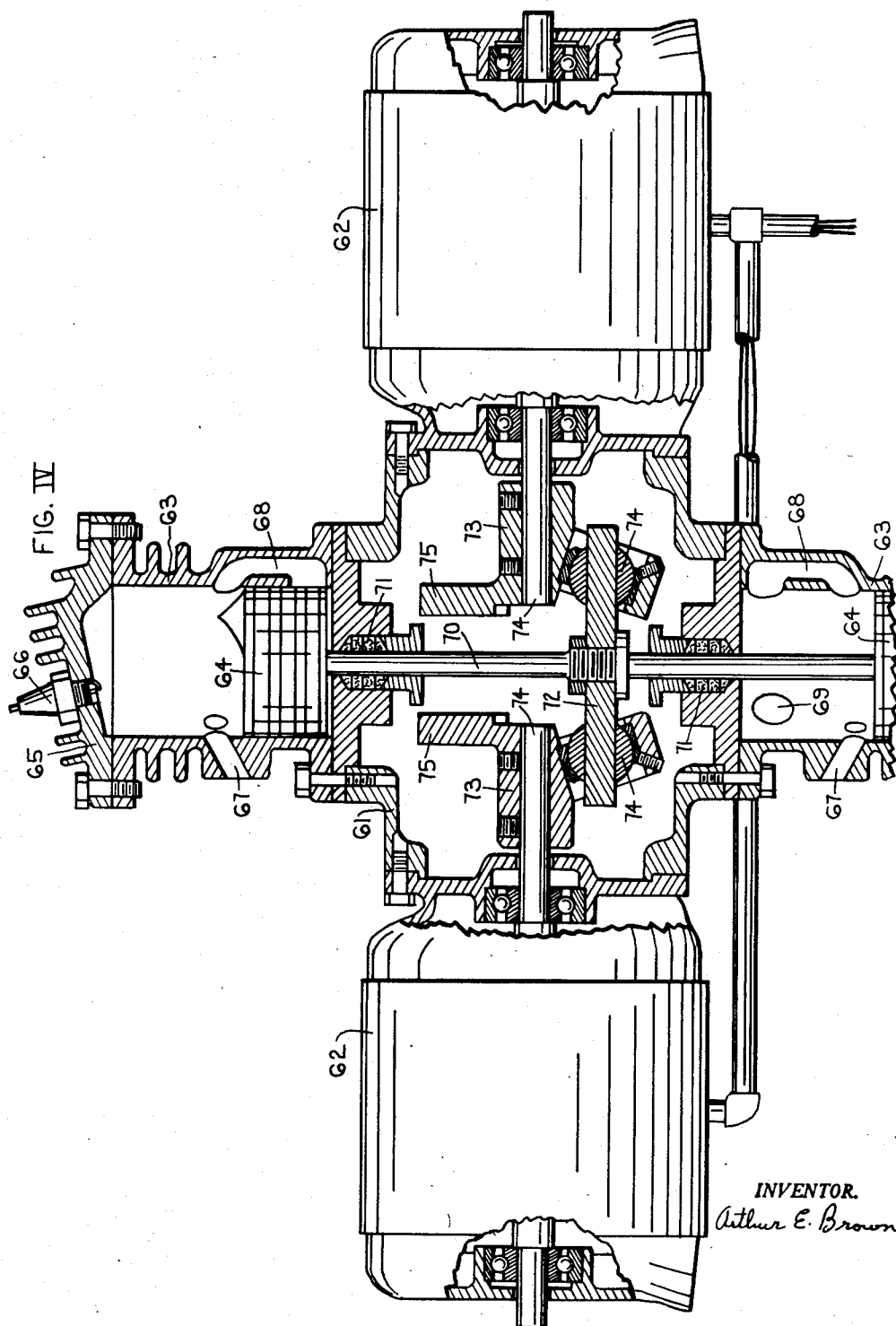
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ELECTRICAL POWER UNIT

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5 Claims. (Cl. 310—112)

This invention relates to mechanism for converting mechanical energy in a reciprocating element into electrical energy or vice versa.

The principal objects of my invention are:

To provide a mechanism which attains a high degree of efficiency in converting mechanical energy in a reciprocating element into electrical energy or vice versa.

To provide a mechanism which is in substantially perfect dynamic balance.

To provide a mechanism in which the forces applied to the reciprocating element are substantially colinear to the axis and direction of motion of the reciprocating element.

To provide a mechanism in which the motion of the reciprocating element is sinusoidal.

To provide a mechanism in which the weight of the reciprocating element is relatively small.

To provide a mechanism which is simple, reliable, and economical to manufacture.

To provide a mechanism in which a binding or jamming action does not result due to small but unavoidable inaccuracies of construction.

To provide a mechanism which is adapted to relatively high operating speeds.

Other objects and advantages of the invention will be apparent during the course of the following description.

In the accompanying drawings, like numerals are employed to designate like parts.

Figure I represents a plan view which illustrates mostly in section a single cylinder double acting compressor. The section is taken on the axis of the cylinder and on the axes of the two electric motors.

Figure II is a sectional view illustrating the rotor, shuttle, and piston rod assembly of the mechanism illustrated in Figure I. The section view shows the positions of the parts when the piston rod is at mid-stroke.

Figure III is a plan view (partly in section) which illustrates a two cylinder single acting compressor. The section is taken on the axis of the cylinders and on the axes of the two electric motors.

Figure IV represents a plan (mostly in section) which illustrates an electric generating system. Two two-cycle internal combustion cylinders are shown adapted to power two electric generators.

It is not to be construed that this invention is limited to compressors or power generators but may be used in connection with many other devices requiring a reciprocating element.

Refer to Figures I and II. A casing or supporting frame 1 supports and encloses the various parts. Two electric motors 2 are fastened to the casing 1. The electric motors shown are squirrel cage induction motors with flange type mountings though they may be of any desired type. The electric motors 2 are provided with the familiar stator magnets 3, stator windings 4, squirrel cage rotors 5, motor shafts 6, motor shaft bearings 7 and 8, cooling fans 9, air vents 10 and 11, and motor end shields 12 and 13. The axes of the motor shafts 6 are made coaxial. A working cylinder 14 is fastened to the casing 1 with its axis perpendicular to the axes of the electric motors. A cross head guide 15 is provided on the casing 1 diametrically opposite the working cylinder 14. The axis of the cross head guide 15 is co-axial with the axis of the working cylinder 14. The cross head guide 15 is circular in cross section. A double acting piston 16 is reciprocable in the cylinder 14. A

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cross head 17 is reciprocable in the cross head guide 15. A piston rod 18 is fastened rigidly to the piston 16. The piston rod 18 is extended so as to also fasten rigidly to the cross head 17. A shuttle 19 is rigidly fastened to the piston rod 18. The shuttle has two cylindrical arms 20 extending perpendicularly from the axis of the reciprocating member or piston rod 18. The two arms 20 have a common axis. The hub portion 21 of the shuttle is threaded on the piston rod 18 against a shoulder and locked in place with a nut 22. Rotors 23 are fastened to the electric motor shafts 6. Bored out holes 24 are provided in the rotors 23 to hold the half rings 25 and 26 which form spherical sockets. The half rings 25 and 26 are held against a shoulder by means of the set screws 27. Balls 28, preferably of antifriction metal, are contained in the spherical sockets. The balls 28 are drilled through to accommodate the cylindrical arms 20 of the shuttle. The drilled balls 28 are both rotatable and slideable on the cylindrical arms 20 of the shuttle member 19. A stuffing box 29 is provided to seal around the piston rod at the casing end of the cylinder. A cylinder head 30 is bolted to the top of the cylinder 14 and contains the valves. The cylinder head 30 is shown in elevation. Valves are also provided at the bottom end of the cylinder. One valve is hidden from view by the piston 16. An electrical conduit pipe 31 is shown interconnecting the two electric motors 2. The lead 32 extends to a source of electrical energy.

Operation of the mechanism illustrated in Figures I and II is as follows: Electrical energy is supplied to the two matched electric motors 2. The motors are electrically connected so as to rotate in opposite directions. Rotation of the motors and the rotors 23, causes the shuttle, piston rod, piston, and cross head to reciprocate and oscillate. The oscillation occurs about the axis of the piston rod.

Counterweights 33 are provided on the rotors 23 diametrically opposite the ball and sockets. The counterweights are proportioned so as to balance the reciprocating weight and the counterweights are positioned in an axial direction along the motor shafts so as to provide a counter-torque to balance the inertia torque caused by the oscillation of the shuttle, piston rod, and piston assembly.

The bearing shoulders in the electric motor to the left have been relieved so that the motor shaft and rotor assembly is free to float a slight amount in an axial direction, the purpose of which is to allow the rotor and ball to float to the correct distance from the piston rod so that a binding or jamming action will not occur.

The linkage system, consisting of the two rotors 23 with ball and socket connections to the shuttle and the piston rod, constrains the two electric driving motors to rotate in unison at all times thus preventing one motor from turning faster than the other. However, the electric driving motors should be matched as nearly as practicable such that they supply equal forces to the shuttle.

A slight differential in forces supplied to the shuttle by the electric driving motors (due to a not quite matched condition of the driving motors) will cause a lateral force on the piston rod. The magnitude of this lateral force will be dependent on the degree with which one electric driving motor is matched to the other and under normal conditions the lateral force will be small compared to the longitudinal forces supplied to the piston rod.

I am aware that prior to my invention, rigid gearing and belt and pulley systems have been employed to drive both rotors or take power off both rotors. It is noted that in my invention, neither rigid gearing nor belt and pulley systems are required to cause both rotors to drive the shuttle; also, fewer bearings and shafts are required in my construction.

Refer to Figure III which illustrates a mechanism similar to the device illustrated in Figures I and II except that two single acting cylinders are shown instead of one double acting cylinder and provision is made to relieve oscillation of the pistons and piston rod. A casing 34 supports and encloses working parts. Two matched electric motors 35 are fastened to the casing 34. The electric motors are provided with the familiar

stator magnets 36, stator windings 37, squirrel cage rotors 38 (shown in elevation), motor shafts 39, motor shaft bearings 40 and 41, cooling fans 42, air vents 43 and 44, and motor end shields 45 and 46. Two working cylinders 47 and 48 are fastened to the casing. The cylinders 47 and 48 are mounted coaxial with their axis perpendicular to the axis of the motor shafts 39. Two single acting pistons 49 and 50 are rigidly mounted on a common piston rod 51. A shuttle 52 is rotatably mounted on the piston rod 51. Thrust washers 53 are provided between the shuttle and a shoulder on the piston rod and between the shuttle and a nut on the piston rod. The rotatable rather than rigid connection of the shuttle to the piston rod is sometimes more desirable in that it lessens friction of the piston rings in the cylinders and relieves the piston rod of torsional loads. The shuttle consists of two cylindrical arms extending from the hub portion of the shuttle. Rotors 54 are fastened to the electric motor shafts 39. Bored out holes are provided in the rotors 54 to hold the half rings which form spherical sockets. Balls 55 are contained in the spherical sockets. The balls 55 are drilled through to accommodate the cylindrical arms of the shuttle. The drilled balls 55 are both rotatable and slideable on the cylindrical arms of the shuttle member 52. The cylinder heads 56 and 57 are bolted to the cylinders and are shown in elevation. An electrical conduit pipe 58 is shown interconnecting the two electric driving motors 35. The lead 59 extends to a source of electrical energy. Counterweights 60 are provided on the rotors diametrically opposite the ball and socket connections.

Refer to Figure IV which illustrates a mechanism in which two two-cycle internal combustion engine cylinders are adapted to drive two matched electric generators. A casing 61 supports and encloses working parts. Two electric generators 62 are fastened coaxially to the casing 61. The generators are shown in elevation except where broken to show shaft bearings and end fastenings. Two two-cycle internal combustion cylinders 63 are fastened coaxially to the casing. One cylinder is shown broken. A piston 64 is reciprocable in each cylinder. The cylinders are provided with the familiar cylinder heads 65, ignition plugs 66, exhaust ports 67, by-passes 68, and pressure responsive inlet valves 69. Each piston 64 is rigidly fastened to a common piston rod 70. Stuffing boxes 71 are provided to seal around the piston rod.

A shuttle 72, similar to that illustrated in Figures I and II, is rigidly fastened to the common piston rod 70. Rotors 73 are rigidly fastened to the generator shafts 74. Each rotor 73 carries a ball and socket connection 74, which articulatively connects to the respective arms of the shuttle 72. The drilled balls 74 are both rotatable and slideable on the cylindrical arms of the shuttle 72. Counterweights 75 are provided on the rotors 73. The mechanism may be started by admitting compressed air to the cylinders or by turning either generator shaft or both.

The term dynamo electric machine means either an electric motor or an electric generator.

I claim:

1. The combination in a power unit of a casing for supporting parts in proper spaced relation, a reciprocable member mounted for reciprocation relative to said casing, a shuttle member fastened to said reciprocable member, said shuttle member having two extending arms, two rotatable shafts mounted for rotation relative to said casing, a crank fastened to each rotatable shaft, each extending arm of said shuttle member being articulatively connected to its respective crank at a position eccentric from the axes of the rotatable shafts, two dynamo electric machines each having a magnetic stator element and a magnetic rotor element, each magnetic rotor element being connected to its respective rotatable shaft, said two dynamo electric machines being substantially matched so that they operate with substantially equal mechanical power, electrical conductors tying said dynamo electric machines together electrically for rotation in opposite directions whereby such rotation is mechanically constrained through said shuttle member, said shuttle member being the sole motion transmitting mechanical member for transmitting power between the reciprocable member and both of said electric machines and for interconnecting the two cranks for rotation in opposite directions with equal ro-

tative speed, and said power unit being adapted to transform power between said reciprocable member and said electrical conductors.

2. The combination in a power unit of a casing for supporting parts in proper spaced relation, a reciprocable member mounted for reciprocation relative to said casing, a shuttle member fastened to said reciprocable member, said shuttle member having two extending arms, two rotatable shafts mounted for rotation relative to said casing, a crank fastened to each rotatable shaft, each extending arm of said shuttle member being articulatively connected to its respective crank at a position eccentric from the axes of the rotatable shafts, two electric induction motors each having a magnetic stator element and a magnetic rotor element, each magnetic rotor element being connected to its respective rotatable shaft, said two electric induction motors being substantially matched so that they operate with substantially equal power output, electrical conductors tying said electric induction motors together electrically for rotation in opposite directions whereby such rotation is mechanically constrained through said shuttle member, said shuttle member being the sole motion transmitting mechanical member for transmitting a substantial amount of the power from both of said electric motors to said reciprocable member and for interconnecting the two cranks for rotation in opposite directions with equal speed, and said power unit being adapted to transform an electrical power input to a reciprocating mechanical power output in which the electrical power input is supplied to said electrical conductors and the reciprocating mechanical power output is obtained from said reciprocable member.

3. The combination in a power unit of a casing for supporting parts in proper spaced relation, a reciprocable member mounted for reciprocation relative to said casing, a shuttle member fastened to said reciprocable member, said shuttle member having two extending arms, two rotatable shafts mounted for rotation relative to said casing, a crank fastened to each rotatable shaft, each extending arm of said shuttle member being articulatively connected to its respective crank at a position eccentric from the axes of the rotatable shafts, two electric generators each having a magnetic stator element and a magnetic rotor element, each magnetic rotor element being connected to its respective rotatable shaft, said two electric generators being substantially matched so that they operate with substantially equal power input, electrical conductors interconnecting said generators electrically for rotation in opposite directions whereby such rotation is mechanically constrained through said shuttle member, said shuttle member being the sole motion transmitting mechanical member for transmitting the power from said reciprocable member to both of said generators and for interconnecting the two cranks for rotation in opposite directions with equal rotative speed, and said power unit being adapted to transform a reciprocating mechanical power input to an electrical power output in which the reciprocating mechanical power input is supplied to said reciprocable member and the electrical power output is obtained from said electrical conductors.

4. A power unit comprising two matched electric machines, each of which has a housing, a magnetic stator element, a magnetic rotor element mounted on a shaft and bearings for said shaft, each shaft extending at one end beyond its respective housing and having a crank fixed thereto, a casing mounting said electric machines with their shafts aligned and said cranks adjacent each other but spaced from each other, a rod mounted for reciprocation in said casing normal to and intersecting the axis of said aligned shafts between said cranks, a two armed shuttle member fixed to said reciprocating rod and having an arm articulated with each of said cranks, electrical conductors tying said machines together electrically for rotation in opposite directions whereby such rotation is mechanically constrained through said shuttle member with reciprocation of said rod, said shuttle member being the sole motion transmitting mechanical member for transmitting a substantial amount of the power of both of said electric machines and for interconnecting the two cranks for rotation in opposite directions with equal rotative speed, and said power unit being adapted to transform power between said rod and said electrical conductors.

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5. The combination in a power unit of a casing for supporting parts in proper spaced relation, a reciprocable member mounted for reciprocation relative to said casing, two rotatable shafts mounted for rotation relative to said casing in the same plane transverse to the axis of said reciprocable member, a crank fastened to each rotatable shaft, two kinematic links, each kinematic link being mounted so as to link its respective crank to the reciprocable member at substantially the same distance from said plane, each kinematic link being adapted to transform the rotative motion of its respective crank to the reciprocative motion of said reciprocable member, two dynamo electric machines each having a magnetic stator element and a magnetic rotor element, each magnetic rotor element being connected to its respective rotatable shaft, said two dynamo electric machines being substantially matched so that they operate with substantially equal mechanical power, electrical conductors tying said dynamo electric machines together electrically for rotation in opposite directions, said kinematic links

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with the reciprocable member being the sole motion transmitting mechanical members for transmitting a substantial amount of power between the reciprocable member and both of said electric machines and for interconnecting the two cranks for rotation in opposite directions with equal rotative speed, and said power unit being adapted to transform power between said reciprocable member and said electrical conductors.

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