Aug. 8, 1961

R. C. GRIFFITH

2,994,995

HIGH-SPEED WHEELHEAD

Filed May 27, 1959

3 Sheets-Sheet 1

FIG. 1.

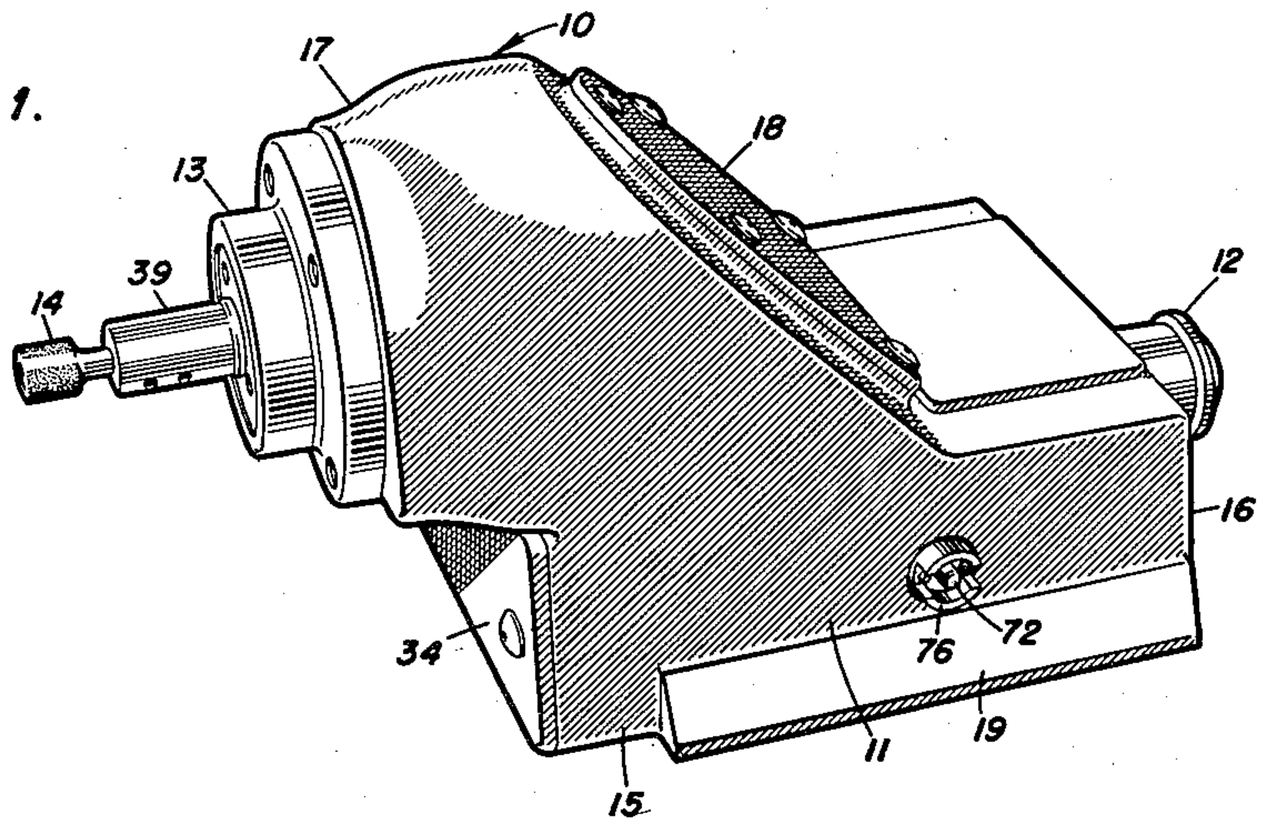
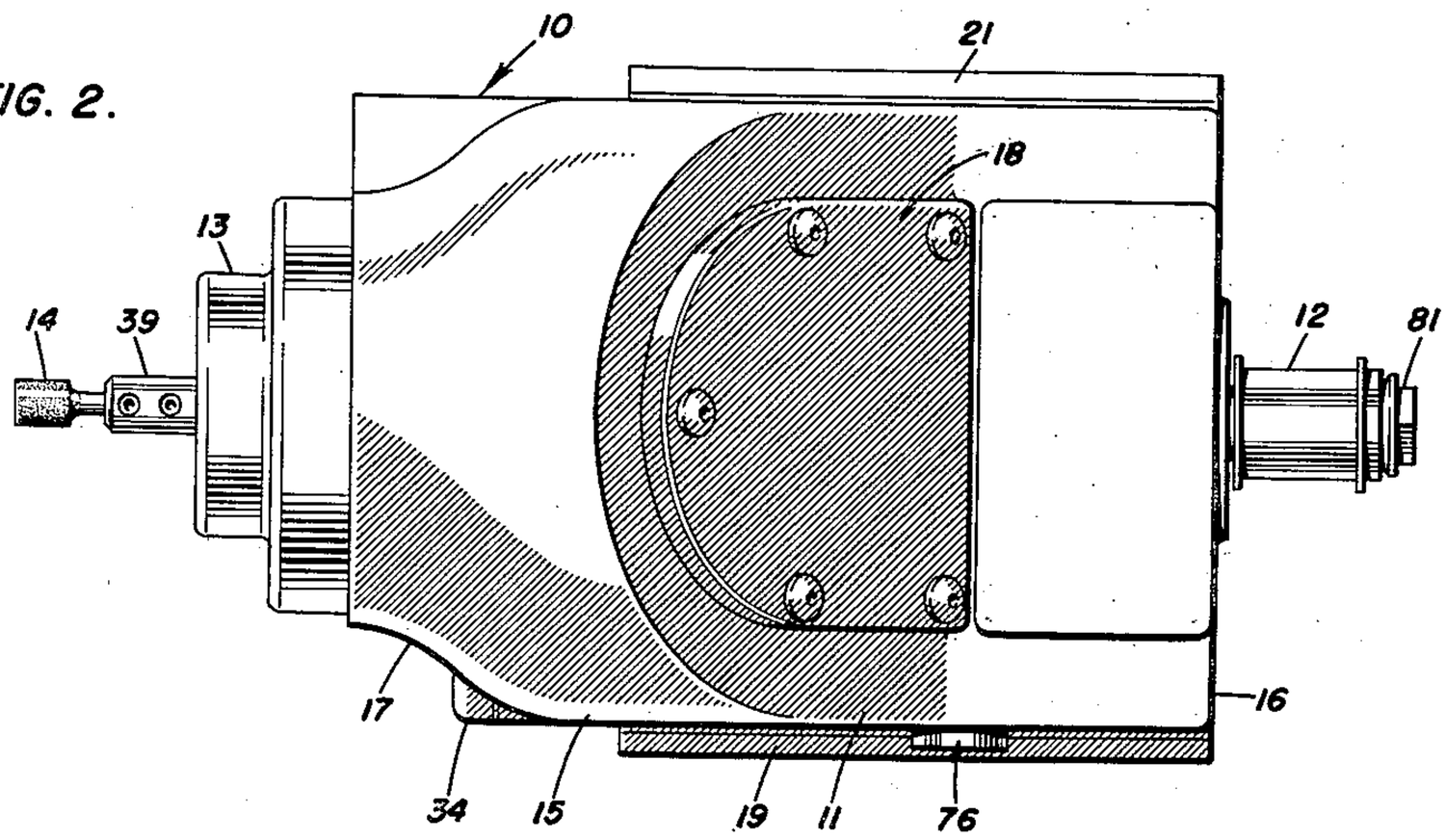


FIG. 2.



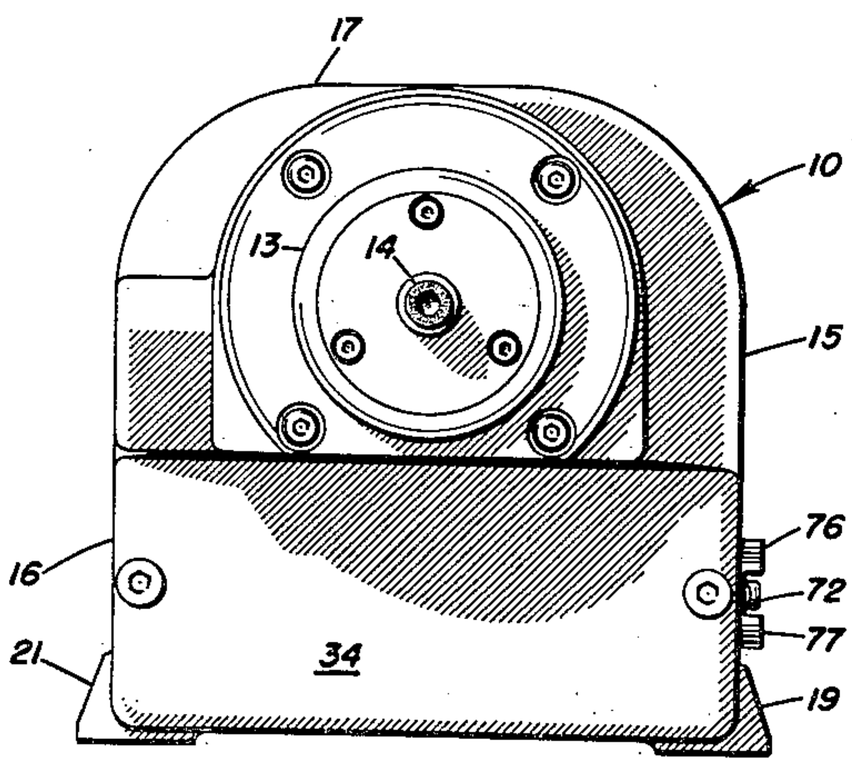


FIG. 3.

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3 Sheets-Sheet 2

FIG. 4.

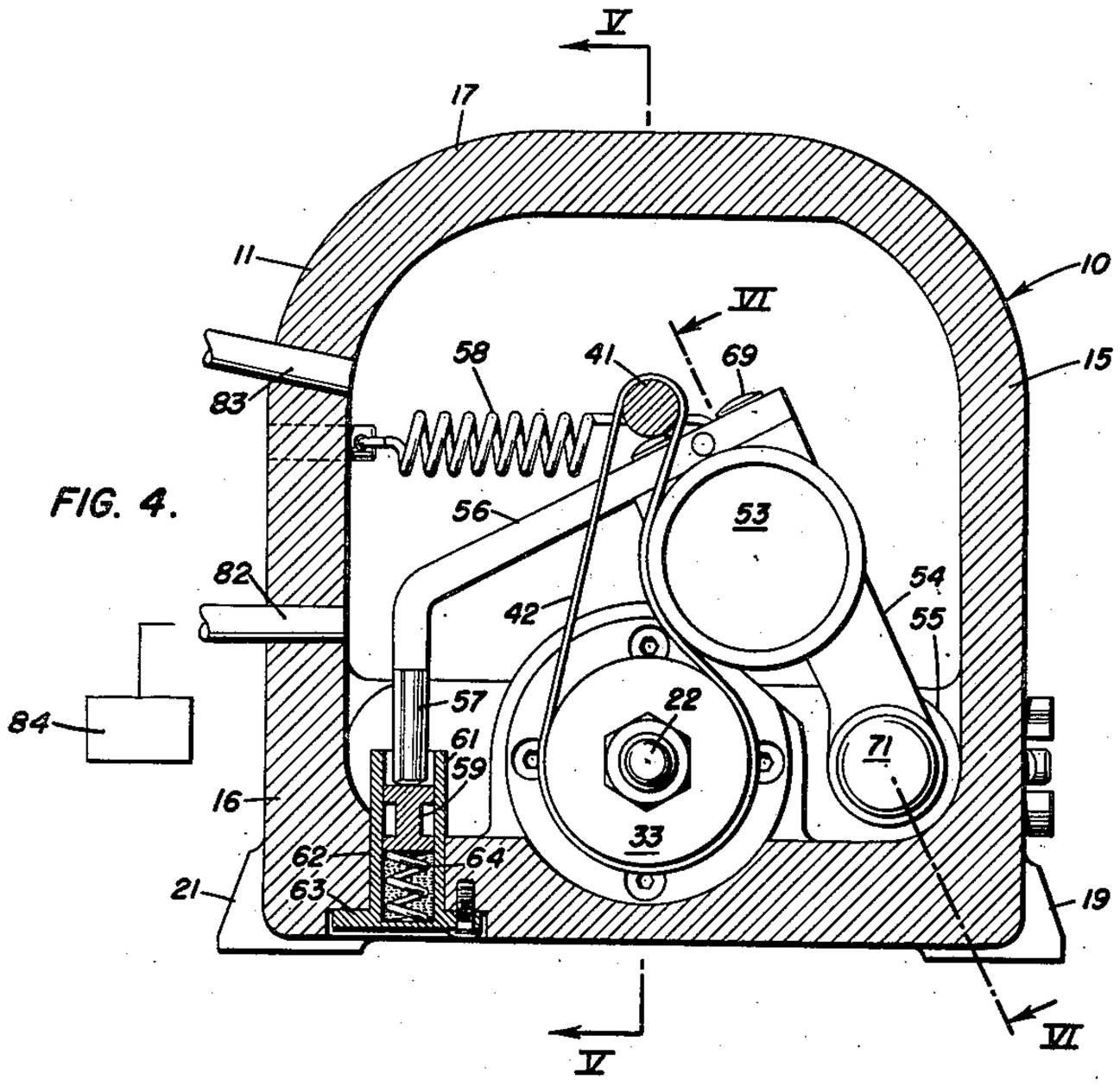
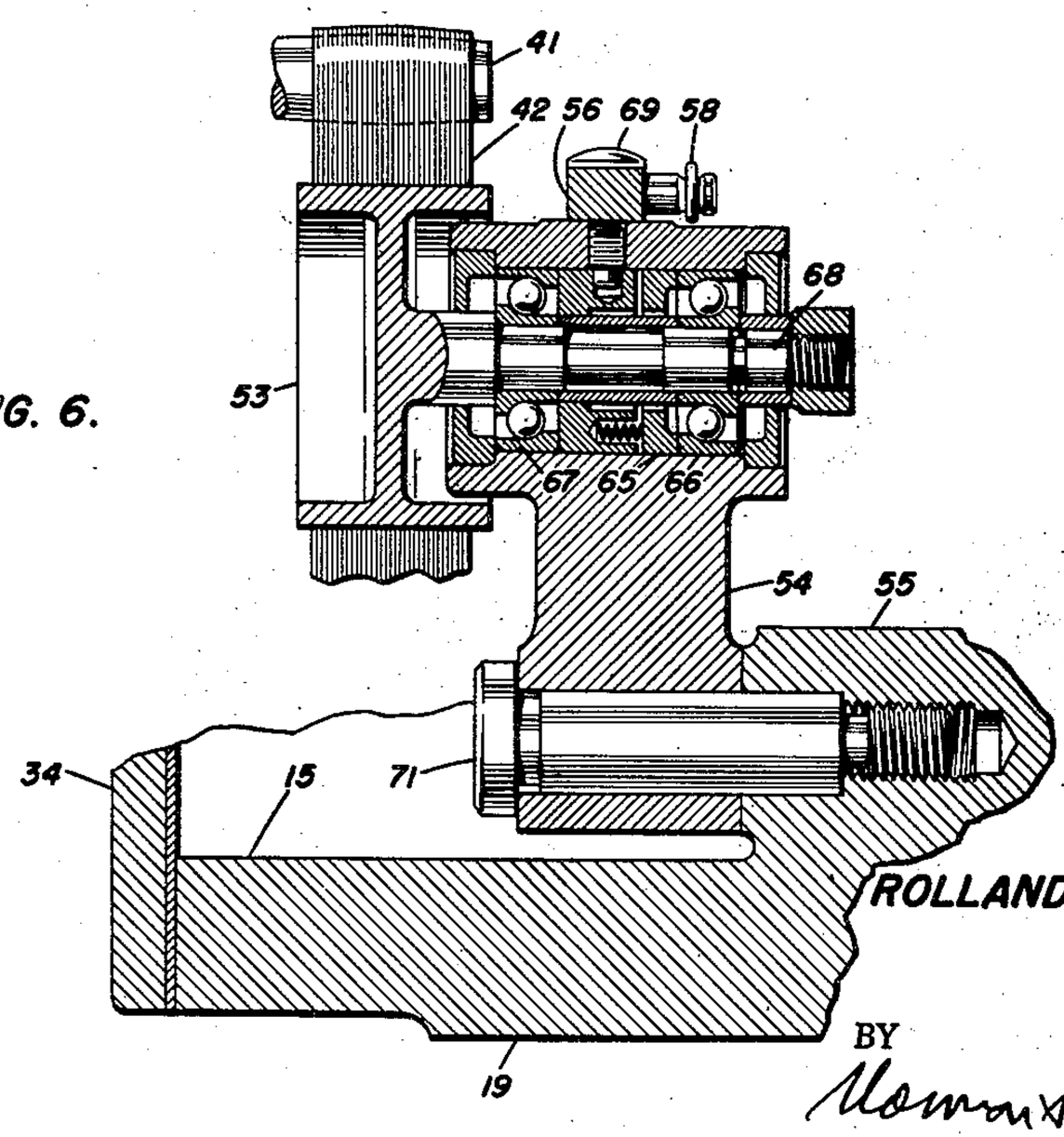


FIG. 6.



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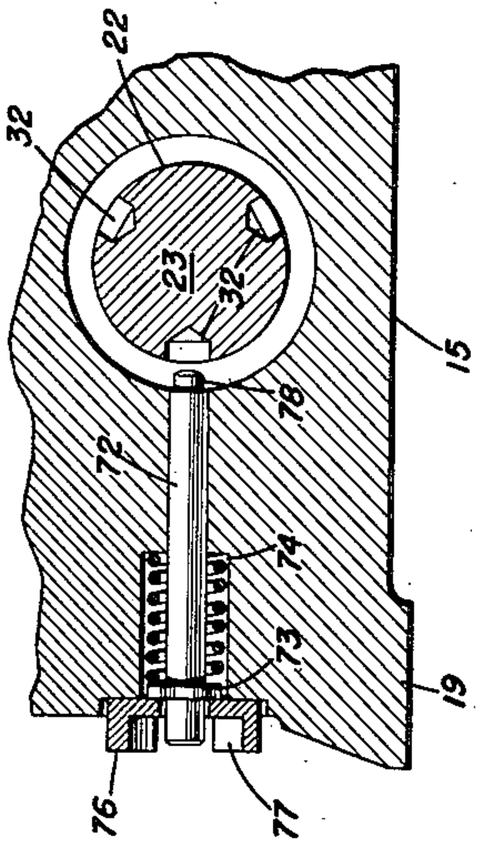

FIG. 7.

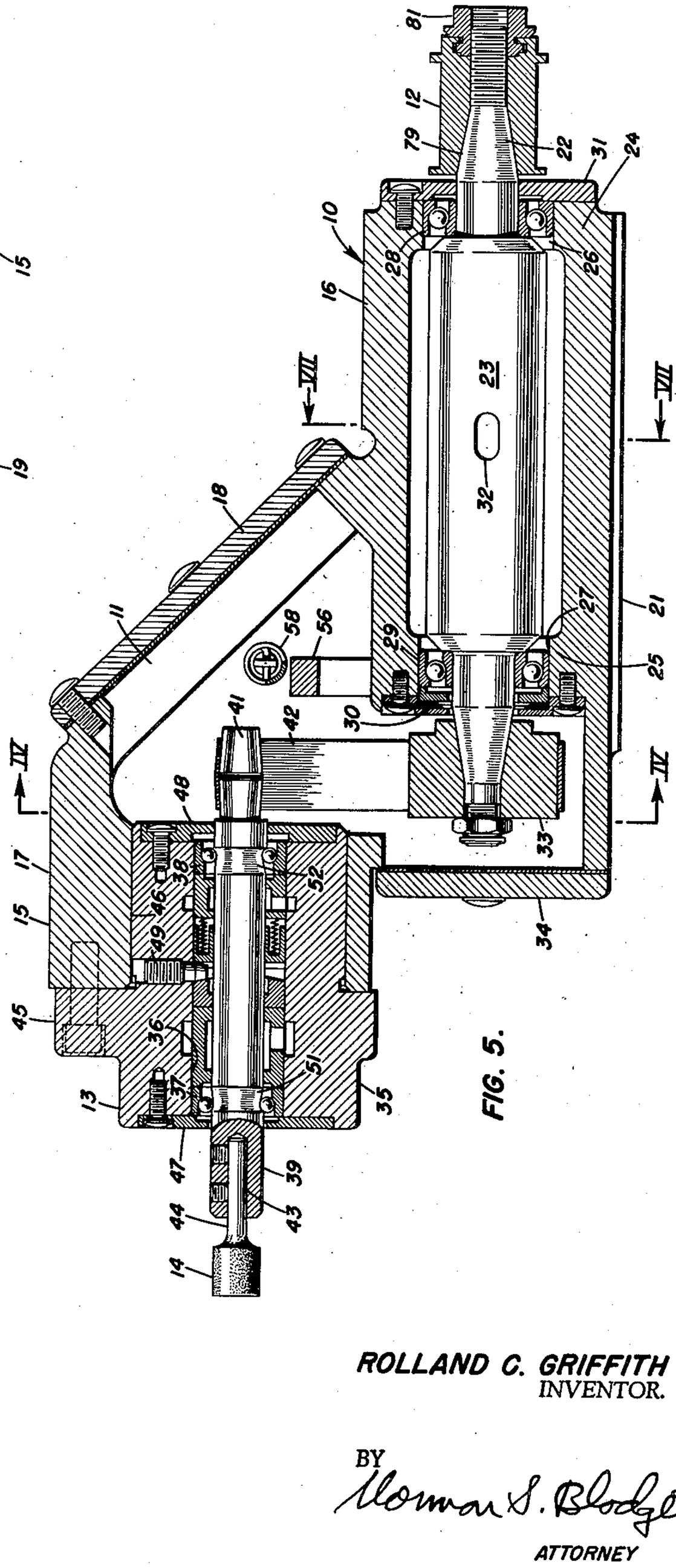

FIG. 5.

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2,994,995

HIGH-SPEED WHEELHEAD

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Filed May 27, 1959, Ser. No. 816,205

8 Claims. (Cl. 51—134.5)

This invention relates to a high-speed wheelhead and more particularly to apparatus arranged to rotate a small grinding wheel or the like at extremely high speeds for the purpose of removing metal from a workpiece.

In the generation of workpiece surfaces by abrasion there is a condition under which the most efficient removal of material from the surface to be finished takes place; this point is usually expressed in terms of surface speed. For example, when one attempts to grind the internal bore of an outer race of an extremely small ball, the internal grinding wheel must also be of very small diameter; in the grinding of such miniature bearings the wheel must rotate at extremely high speed in order to reach the aforementioned optimum surface speed. In the past there have been limitations on increasing the speeds of wheelheads, however, for a number of reasons. In the case of high-speed wheelheads, where the motor is an integral part of the head and there is no speed increase through a gear train, it is necessary to provide a high-frequency motor and this requires expensive equipment for producing the high-frequency electrical impulses. Attempts to obtain a high-speed wheelhead using a belt drive from an external motor have been somewhat less than successful. Furthermore, prior designs of high-speed wheelheads have been somewhat limited from an economic point of view because of the narrow range of speeds in which they may be effectively used; a high-speed wheelhead designed for a high speed would not grind satisfactorily at a low speed. These and other difficulties experienced with the prior art devices have been obviated in a novel manner by the present invention.

It is, therefore, an outstanding object of the invention to provide a high-speed wheelhead capable of operation at speeds in the order of 100,000 r.p.m.

Another object of this invention is the provision of a high-speed wheelhead which is belt driven and yet is substantially free of vibration.

A further object of the present invention is the provision of a high-speed wheelhead in which the speed-increase mechanism is totally enclosed within the housing.

It is another object of the instant invention to provide a high-speed wheelhead in which the portion thereof containing the bearings which are subjected to the highest speed of operation is readily removable and replaceable.

It is a further object of the invention to provide a high-speed wheelhead in which the range of speeds is readily changed.

A still further object of this invention is the provision of a high-speed wheelhead of simple and yet rugged construction which is capable of a long life of useful service.

It is a still further object of the present invention to provide a belt-driven high-speed wheelhead particularly adapted for use in the grinding of miniature bearing races at speeds in the order of 100,000 r.p.m. and which is substantially free of vibrations.

Another object of the invention is the provision of a high-speed wheelhead capable of providing fine finish because of adequate surface speeds in small hole grinding with a low initial cost because of the lack of need for high-frequency electrical generating equipment and of the versatility resulting from interchangeable cartridges.

Although the novel features which are believed to be characteristic of this invention will be particularly pointed out in the claims appended hereto, the invention itself,

as to its objects and advantages, the mode of its operation and the manner of its organization may be better understood by referring to the following description taken in connection with the accompanying drawings forming a part thereof, in which:

FIG. 1 is a perspective view of a wheelhead embodying the principles of the present invention;

FIG. 2 is a plan view of the wheelhead;

FIG. 3 is a vertical elevational view of the invention as observed from the wheel end;

FIG. 4 is a vertical sectional view taken on the line IV—IV of FIG. 5;

FIG. 5 is a vertical sectional view of the wheelhead taken on the line V—V of FIG. 4;

FIG. 6 is an enlarged view of a portion of the wheelhead taken on the line VI—VI of FIG. 4; and

FIG. 7 is an enlarged view of a portion of the invention taken on the line VII—VII of FIG. 5.

For the purposes of this specification the expression "longitudinal" will be used to indicate the direction of the axis of the wheel, while the expression "transverse" will be used to indicate directions at right angles to the axis of the wheel.

Referring now to FIG. 1, wherein are best shown the general features of the invention, the wheelhead, indicated generally by the reference numeral **10**, is shown as consisting of a main portion **11** having an input pulley **12** extending from one end and a cartridge **13** extending from the other end and having an abrasive wheel **14** mounted thereon. The main portion **11** is enclosed in a housing **15** having a generally box-like rectangular lower portion **16** on which is mounted a somewhat cylindrical upper portion **17** having an inclined rear surface provided with an access opening normally closed by means of a plate **18**. The lower portion **16** of the housing **15** is provided with feet **19** and **21** to permit it to be suitably mounted on the base of a grinding machine or the like.

Referring next to FIG. 5, which shows the mounting of the shafts and the method of speed increase, it can be seen that the pulley **12** is mounted at the end of a jackshaft **22** which extends from the back end of the housing **15**. The jackshaft **22** is provided at each end with reduced portions between which lies a massive center portion **23**. The housing **15** is provided with a rear wall **24** and an intermediate wall **25** having aligned bores **26** and **27**, respectively, in which are mounted ball bearings **28** and **29** which support the jackshaft **22**. A suitable seal plate **31** covers the rearward opening of the bore **26** and the bearing contained therein. It should be noted that the central portion **23** of the jackshaft **22** is provided with an elongated slot **32**, the purpose of which will be explained more fully hereinafter. At the forward end of the jackshaft, a Belleville spring **30** provides pre-loading of the bearings. The forward reduced end of the jackshaft **22** is also suitably provided with a tapered portion and a threaded portion on which a pulley **33** is mounted and held in place by a captive nut which also acts to pull the pulley out of locked engagement with the tapered portion of the shaft. The front of the housing **15** is provided with an opening which is adjacent the pulley **33** and which is normally closed by a cover **34**.

The cartridge **13** is made up of a main body **35** having a bore **36** extending therethrough. Suitably mounted and spaced within the bore **36** are ball bearings **37** and **38** which carry the high-speed shaft **39**. The portions of the shaft **39** adjacent the bearings **37** and **38** are provided with annular grooves for direct engagement by the balls of the bearings; the bearings having no inner races in the usual sense. The rearward end of the shaft **39** is formed as a small pulley **41** and is provided with a crown to receive a belt **42** by which it is driven from the pulley **33**. At the outer end the shaft **39** is provided

with an axial recess 43 to receive the spindle 44 of the wheel 14. Suitable threaded apertures extend into the recess 43 for use with set screws for locking the spindle in place. It should be noted that the main body 35 of the cartridge 13 has a generally cylindrical outer surface provided with a circular flange 45 which extends radially outwardly therefrom at an intermediate position. The housing 15 is provided with a bore 46 in which the rearward end of the said cylindrical surface of the main body 35 is inserted, the flange 45 resting against the outer surface of the housing at that time. Suitable seals 47 and 48 enclose the ends of the bore 36 of the cartridge to retain the bearings and other elements in place and a suitable set screw 49 locks these elements in place also. On close examination it can be seen that the groove 51 associated with the ball bearing 37 and the groove 52 formed in the shaft 39 and associated with the ball bearing 38 are of a rather unusual configuration. The groove 51 at its forward end (that is to say, closest to the wheel 14) is provided with an annular section which is circular in cross-section and which merges with a frusto-conical section leading to the rear part of the shaft; the groove 52 is the exact reverse and has a circular annular portion adjacent the pulley 41 which merges into a conical portion extending in the direction of the wheel 14. The pressure of the elements lying between the bearings forces the balls of these bearings back against the shoulder provided by the annular portion of circular cross-section and serves to prevent longitudinal movement of the shaft 39.

In FIG. 4 it can be seen that the pulley 41 associated with the high-speed shaft 39 is located vertically above the pulley 33 and, as has been described before, is connected to a belt 42. The intermediate portion of the belt 42 rides over an idler pulley 53 which is pivotally mounted on an arm 54, the other end of which is pivotally attached to an abutment 55 forming part of the housing 15. The upper end of the arm 54 has attached thereto an extension 56 which extends over the shaft 22 and terminates in a vertical portion 57 having a rounded lower end. An intermediate portion of the extension 56 is connected through a coil spring 58 to the opposite side of the housing 15. The vertical end portion 57 of the extension rests on a free piston 59 which slides in a cylinder 61. The cylinder is mounted in the lower part of the housing 15 and extends upwardly through a bore 62 extending through the floor of the housing. The cylinder is provided with a flanged bottom 63 which resides and is bolted in a recess provided therefor in the bottom of the housing. A coil spring 64 resides between the piston and the bottom of the cylinder 61, and this space is also occuplied by a viscous material such as grease.

The details of the mounting of the pulley 53 on the arm 54 and its association with the extension 56 is clearly shown in FIG. 6. The upper end of the arm 54 is provided with a longitudinal bore 65 which carries a set of ball bearings 66 and 67 which in turn support a shaft 68 extending axially of the pulley 53. It can be seen that the extension 56 is suitably bolted by means of a cap screw 69 to the upper end of the arm 54. A pivot bolt 71 fastens the lower end of the arm 54 to the abutment 55 of the housing 15.

In FIG. 7 is shown an arrangement associated with the housing 15 for locking the main shaft against rotation when it is desired to remove and replace the pulley 12. An elongated pin 72 extends through the housing 15 in line with the center-line of the shaft 22. The pin is provided with a flange 73 which resides within a counterbore 74 and is slidable therein. A coil spring extends between the flange 73 and the bottom of the counterbore 74 and surrounds the pin 72. An element 76 is bolted to the outside of the housing to serve a primary function of closing the opening to the counterbore 74 and of retaining the flange 73 and the pin therewithin; it serves a secondary function by means of a flange 77 of preventing the protruding end of the shaft 72 from being actuated during normal operation of the machine. As is evident from the drawings, the slots 32 are in line with the pin 72 and may be engaged by a reduced portion 78 of the pin, the reduced portion normally residing in the space surrounding the enlarged portion 23 of the jackshaft 22. Referring to FIG. 5 it can be seen that the pulley 12 is held on the shaft 22 because of the provision of a tapered portion 79 on which a corresponding tapered portion of the pulley 12 is driven. The pulley is held on the shaft by means of a nut 81 so that it is necessary to lock the shaft in order to loosen the nut 81 to remove or replace the pulley which is an operation carried out quite often under certain circumstances, as will be described more fully hereinafter.

The operation of the apparatus of the invention will now be readily understood in view of the above description. Assuming that the wheelhead is to be used in a grinding machine with an abrasive wheel 14, as has been described above, the drive motor (not shown) which may, incidentally, be an inexpensive alternating current motor, is connected by a belt (not shown) to the pulley 12. This serves to drive the jackshaft 22 and the pulley 33. The rotation of the pulley 33 acts through the belt 42 to rotate the pulley 41 which is integrally formed with the shaft 39. The rotation of the shaft 39 brings about the desired high-speed rotation of the wheel 14. The fact that the central portion 23 of the jackshaft 22 has tremendous rotational inertia guarantees that the jackshaft 22 rotates without any substantial variations in torque. The high-speed shaft 39 and its associated equipment are very light and are able to follow the rotation of the shaft 22 without difficulty. The tension in the belt 42 which joins the pulley 33 to the pulley 41 is maintained at a constant value by means of the pressure exerted upon it by the idler pulley 53, the pressure being maintained at a constant value by the coil spring 58. Because of the presence in the idler and drive system of certain resilient elements, there would normally be a tendency for a frequency-sensitive resilient condition and, at particular points relative to the natural frequency of the system, the amplitude of the vibrations generated would be quite considerable. To do away with this possibility, any movement of the idler wheel 53 on the arm 54 at the pivot presented by the pivot bolt 71 is damped by the pressure of the vertical end portion 57 against the piston 59. This piston resists downward movement not only because of the spring 64 which gives a straight-line damping condition, but also because of the oil in the dash pot made up of the piston 59 and the cylinder 61, which gives viscous damping. The net result is the suppression of any increase in vibration amplitude even under the most critical conditions.

There are several ways in which the frequency of rotation of the wheel may be changed. In the preferred version of the invention the wheelhead is designed to produce rotational rates anywhere from the range from 60,000 r.p.m. to 100,000 r.p.m. It is contemplated that two sets of cartridges 13 be provided, one with a small pulley 41 and the other with a large pulley. The cartridge with the small pulley would be used for the higher frequencies in the order of 100,000 r.p.m. where the cartridge with the large pulley would be used in the lower frequencies. In order to select precisely determined rotation rates within the two ranges the pulley 12 is used, since the size of the pulley 12 can also determine the rate of rotation of the wheel 14. Since the pulley 12 may be changed quite frequently under short-job conditions, the keying or locking mechanism represented by the pin 72 is quite important. When it is desired to loosen the nut 81 to remove the pulley 12, the operator presses the extending end of the pin 72

against the pressure represented by the spring **74** and rotates the shaft **22** by hand until the reduced portion **78** snaps into one of the slots **32**. Normally, the protruding end of the pin is protected because of the flange **77** surrounding it; therefore, a deliberate effort must be made to press the pin. Once the pin is inserted in the slot, the shaft **22** is prevented from rotating so that the operator is able to loosen the nut **81** by applying a wrench or the like. When the change of pulley has been accomplished, the protruding end of the pin **72** is released and the shaft is free to rotate in the usual manner. It is important that the operator have access to the wheelhead for the purpose of changing bolts and the like and for that purpose the plate **18** is provided. When the plate **18** is removed the back end of the wheelhead is open and the operator has access to the interior. He may then thread his belt easily at the time a cartridge **13** is being changed and, of course, he may wish to open the cover **34** to provide access to the pulley **33** and its immediate area.

It should be noted at this point that the cartridge **13** is changeable to present different size pulleys **41** effectively to change the range of speeds of the wheel. However, it is also changeable because of the fact that the bearings in this high-speed end of the wheelhead may need changing from time to time. Instead of repairing the whole wheelhead and taking it out of its grinding machine for repair, it is only necessary to replace the cartridge and, then, one may change the bearings in the cartridge at his leisure. It is contemplated that the machine operator keep on hand several cartridges that might be used as replacements. For the first time it is possible with this apparatus to obtain spindle speeds up to 100,000 r.p.m. on internal grinding machines or the like without the need for high-frequency generating equipment. This new high-speed belt driven wheelhead offers to manufacturers a relatively inexpensive means of small hole grinding at the proper surface speeds. It can be seen that one of the new features of this wheelhead is the provision of the interchangeable cartridge-type arrangement wherein the basic wheelhead consists of a jackshaft, body unit, and a spindle cartridge. It is contemplated that two interchangeable spindle cartridges be provided for spanning a speed range from 45,000 to 100,000 r.p.m. One cartridge operates in the speed range from 45,000 to 60,000 r.p.m., and the other cartridge operates from 70,000 to 100,000 r.p.m., each cartridge having three separate speeds obtainable by changing main line pulleys **12**. The ease of cartridge inter-change and the simplicity of changing from one speed to another within the range of each cartridge makes the application of this high-speed belt driven wheelhead excellent where frequent setup changeovers are necessary in addition to being ideally suited for long production runs.

It is contemplated, in addition to regular application of the usual oil lubrication to the bearings **28** and **29** of the main jackshaft **22** and to the bearings **65** and **67** associated with the pulley **53**, as well as the viscous damping oil provided for the cylinder **61**, that the high-speed shaft **39** has its bearings **37** and **38** lubricated by an air mist arrangement. The housing **15** is, of course, hollow and the lubricating mist is introduced through an aperture **82** and removed through another exhaust aperture **83**. The presence of an oil mist within the housing will assure that the high-speed bearings **37** and **38** are well lubricated. The shape of the grooves **51** and **52** relative to the balls of the ball bearings is such that condensed mist within these bearings will be carried down to the point of contact between the balls and the grooves by capillary action. The entrance aperature **82** for the mist is connected to an oil mist lubricator **84** of the conventional type, whereas the exhaust aperture **83** can be piped to an area where exhaust air and condensed oil mist will not be objectionable. The oil mist lubricator is connected to a reservoir which is kept filled with a light oil.

The lubricator also has associated therewith a pressure regulator which is adjusted to 20 lbs. per square inch and, after the lubricator is making an oil mist, it is connected to the housing **15**; the wheelhead is not used until the escaping oil can be detected in the exhaust. This means that the housing is filled with the oil mist and the proper conditions for operation are in effect. The air supplied to the oil mist lubricator must be filtered.

While certain novel features of the invention have been shown and described and are pointed out in the annexed claims, it will be understood that various omissions, substitutions and changes in the forms and details of the device illustrated and in its operation may be made by those skilled in the art without departing from the spirit of the invention.

The invention having been thus described, what is claimed as new and desired to secure by Letters Patent is:

1. A high-speed grinding wheelhead, comprising a hollow housing, a jackshaft having a relatively high rotational inertia mounted in the housing and having one end that extends outwardly thereof, a removable pulley mounted on the said end of the jackshaft, a high-speed shaft having a relatively low rotational inertia mounted in the housing parallel to and spaced from the said jackshaft, one end of the high-speed shaft extending from the housing at a side thereof opposite the side from which the jackshaft extends, the said one end of the high-speed shaft being adapted to receive an abrasive wheel, the other end of the jackshaft and the other end of the high-speed shaft each having a pulley, a flexible belt joining the last-named pulleys in driving relationship, a resiliently-biased idler wheel over which the belt also passes, and a viscous damping device connected to the idler wheel to reduce vibratory motion thereof.

2. A high-speed wheelhead, comprising a hollow housing, a jackshaft having a relatively high rotational inertia mounted in the housing and having one end that extends outwardly thereof, a removable pulley mounted on the said end of the jackshaft, a generally cylindrical cartridge mounted in the housing and extending therefrom, the cartridge being capable of being readily removed from the housing, a high-speed shaft having relatively low rotational inertia mounted in the cartridge so as to be parallel to and spaced from the said jackshaft, one end of the high-speed shaft extending from the cartridge at a side of the housing opposite the side from which the jackshaft extends, the said one end of the high-speed shaft being adapted to receive an abrasive wheel, the other end of the jackshaft and the other end of the high-speed shaft each having a pulley, a flexible belt joining the last-named pulleys in driving relationship, a resiliently-biased idler wheel over which the belt also passes, and a viscous damping device connected to the idler wheel to reduce vibratory motion thereof.

3. A high-speed wheelhead, comprising a hollow housing, a jackshaft having a relatively high rotational inertia mounted in the housing and having one end that extends outwardly thereof, a removable pulley mounted on the said end of the jackshaft, threaded means for maintaining the pulley on the jackshaft, a generally cylindrical cartridge formed in the housing and extending therefrom, the cartridge being capable of being readily removed from the housing, the high-speed shaft having relatively low rotational inertia mounted in the cartridge so as to be parallel to and spaced from the jackshaft, one end of the high-speed shaft extending from the cartridge at a side of the housing opposite the side from which the jackshaft extends, the said one end of the high-speed shaft being adapted to receive an abrasive wheel, the other end of the jackshaft and the other end of the high-speed shaft each having a pulley, a flexible belt joining the last-named pulleys in driving relationship, a resiliently-biased idler wheel over which the belt also passes, a viscous damping device connected to the idler wheel to reduce vibratory

motion thereof, the jackshaft having a recess formed therein, a pin extending through the housing and having one end extending from the housing and the other end adjacent the recess in the jackshaft, and a spring normally biasing the pin out of engagement with the said recess.

4. A high-speed grinding wheelhead, comprising a hollow housing having a box-like lower portion and a generally cylindrical upper portion, one end of the upper portion being formed with a surface which is inclined at a substantial angle to the vertical, an access opening in the said inclined surface, a closure plate normally fastened over the said opening, a jackshaft having a relatively high rotational inertia mounted in the lower portion of the housing and having one end that extends outwardly thereof, a pulley mounted on the said end of the jackshaft, threaded means for maintaining the pulley on the jackshaft, a high-speed shaft having relatively low rotational inertia mounted in the generally cylindrical upper portion of the housing parallel to and spaced from the said jackshaft, one end of the high-speed shaft extending from the housing and a side thereof opposite the side from which the jackshaft extends, the said one end of the high-speed shaft being adapted to receive an abrasive wheel, ball bearings in which the high-speed shaft is mounted, means for providing oil mist lubrication of the said ball bearings, annular grooves formed in the said high-speed shaft for receiving the balls of the said bearings, the other end of the jackshaft and the other end of the high-speed shaft each having a pulley, a flexible belt joining the last-named pulleys in driving relationship, a resiliently-biased idler wheel over which the belt also passes, and a viscous damping device connected to the idler wheel to reduce vibratory motion thereof, the jackshaft having a recess formed therein, a pin extending through the housing having one end extending from the housing and the other end adjacent the recess in the jackshaft, and a spring normally biasing the pin out of engagement with the said recess.

5. A high-speed grinding wheelhead comprising a hollow housing having a box-like lower portion and a generally cylindrical upper portion, one end of the upper portion being formed with a surface which is inclined at a substantial angle to the vertical, an access opening in the said inclined surface, a closure plate normally fastened over the said opening, a jackshaft having a relatively high rotational inertia mounted in the lower portion of the housing and having one end that extends outwardly thereof, a removable pulley mounted over the said end of the jackshaft, a generally cylindrical cartridge mounted in the generally cylindrical upper portion of the housing and extending therefrom, the cartridge being capable of being readily removed from the housing, the high-speed shaft having relatively low rotational inertia mounted in the cartridge so as to be parallel to and spaced from the said jackshaft, ball bearings in which the high-speed shaft is mounted, means for providing oil mist lubrication of the said ball bearings, annular grooves formed in the high-speed shaft for receiving the balls of the said bearings, one end of the high-speed shaft extending from the cartridge at a side of the housing opposite the side from which the jackshaft extends, the said one end of the high-speed shaft being adapted to receive an abrasive wheel, the other end of the jackshaft and the other end of the high-speed shaft each having a pulley, a flexible belt joining the last-named pulleys in driving relationship, a resiliently-biased idler wheel over which the belt also passes, and a viscous damping device connected to the idler wheel to reduce vibratory motion thereof.

6. A high-speed grinding wheelhead comprising a hollow housing having a box-like lower portion and a generally cylindrical upper portion, one end of the upper portion being formed with a surface which is inclined at a substantial angle to the vertical, an access opening in the said inclined surface, a closure plate normally fastened over the said opening, a jackshaft having relatively high rotational inertia mounted in the lower portion of the housing and having one end that extends outwardly thereof, a removable pulley mounted on the said end of the jackshaft, threaded means for maintaining the pulley on the jackshaft, a generally cylindrical cartridge mounted in the generally cylindrical upper portion of the housing and extending therefrom, a high-speed shaft having relatively low rotational inertia mounted in the cartridge so as to be parallel to and spaced from the said jackshaft, ball bearings in which the high-speed shaft is mounted, means for providing oil mist lubrication of the said ball bearings, annular grooves formed in the high-speed shaft for receiving the balls of the said bearings, one end of the high-speed shaft extending from the cartridge at a side of the housing opposite the side from which the jackshaft extends, the said one end of the high-speed shaft being adapted to receive an abrasive wheel, the other end of the jackshaft and the other end of the high-speed shaft each having a pulley, a flexible belt joining the last-named pulleys in driving relationship, a resiliently-biased idler wheel over which the belt also passes, a viscous damping device connected to the idler wheel to reduce vibratory motion thereof, the jackshaft having a recess formed therein, a pin extending through the housing having one end extending from the housing and the other end adjacent the recess in the jackshaft, and a spring normally biasing the pin out of engagement with the said recess.

7. A high-speed grinding wheelhand, comprising a hollow housing, a jackshaft having a relatively high rotational inertia mounted in the housing and having one end that extends outwardly thereof, a pulley mounted on the said end of the jackshaft, threaded means for maintaining the pulley on the jackshaft, a high-speed shaft having a relatively low rotational inertia mounted in the housing parallel to and spaced from the said jackshaft, one end of the high-speed shaft extending from the housing at a side thereof oposite the side from which the jackshaft extends, the said one end of the high-speed shaft being adapted to receive an abrasive wheel, the other end of the jackshaft and the other end of the high-speed shaft each having a pulley, a flexible belt joining the last-named pulleys in driving relationship, a resiliently-biased idler wheel over which the belt also passes, a viscous damping device connected to the idler wheel to reduce vibratory motion thereof, the jackshaft having a recess formed therein, a pin extending through the housing and having one end extending from the housing and the other end adjacent the recess in the jackshaft, and a spring normally biasing the pin out of engagement with the said recess.

8. A high-speed grinding wheelhead, comprising a hollow housing having a box-like lower portion and a generally cylindrical upper portion, one end of the upper portion being formed with a surface which is inclined at a substantial angle to the vertical, an access opening in the said inclined surface, a closure plate normally fastened over the said opening, a jackshaft having a relatively high rotational inertia mounted in the lower portion of the housing and having one end that extends outwardly thereof, a removable pulley mounted on the said end of the jackshaft, a high-speed shaft having a relatively low rotational inertia mounted in the generally cylindrical upper portion of the housing parallel to and spaced from the said jackshaft, ball bearings in which the high-speed shaft is mounted, means for providing oil mist lubrication of the said ball bearings, annular grooves formed in the high-speed shaft for receiving the balls of the said bearings, one end of the high-speed shaft extending from the housing at a side thereof opposite the side from which the jackshaft extends, the said one end of the high-speed shaft being adapted to receive an abrasive wheel, the other end of the jackshaft and the other end of the high-speed shaft each having a pulley, a flexible belt joining the last-named pulleys in driving relationship, a resiliently-biased idler

wheel over which the belt also passes, and a viscous damping device connected to the idler wheel to reduce vibratory motion thereof.

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