Nov. 11, 1930. E. H. SHAFF 1,781,131

PRESSURE FLUID MOTOR

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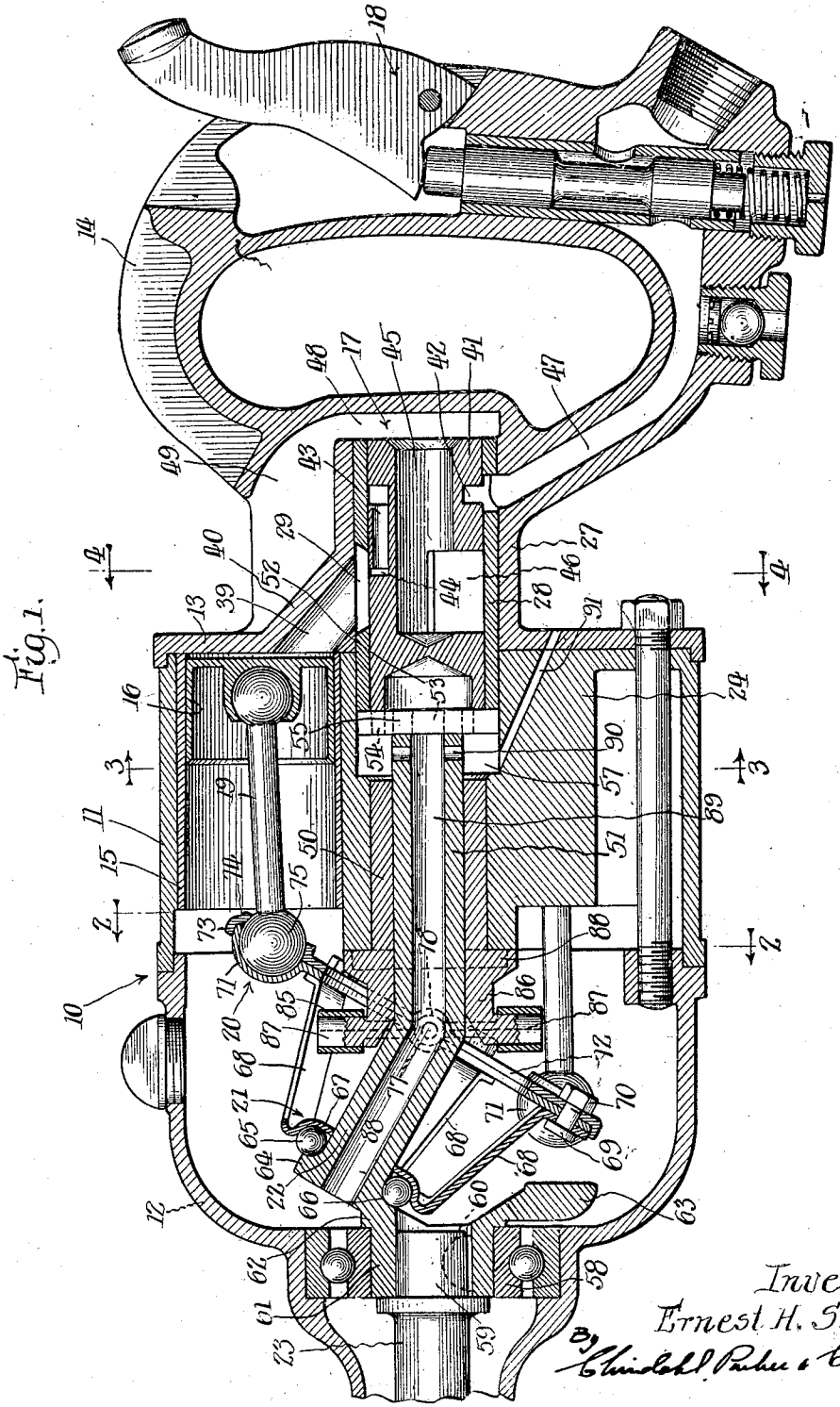


Fig. 1.

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Fig. 2.

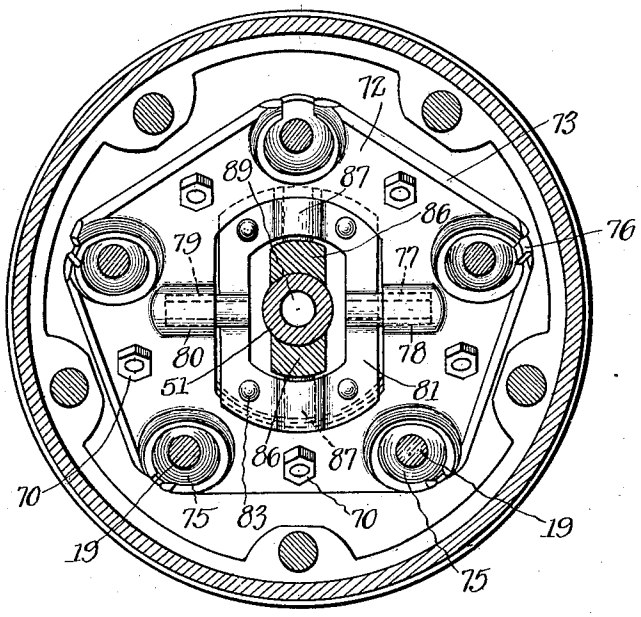
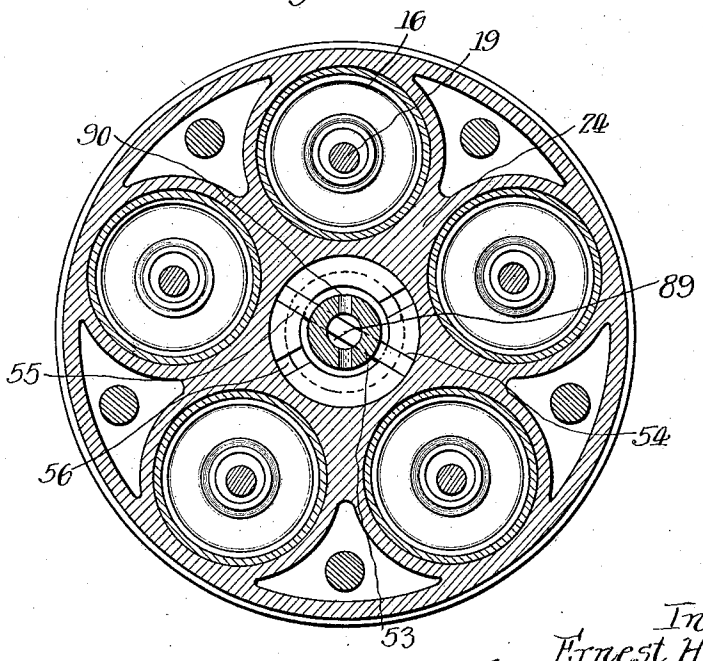


Fig. 3.



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Fig. 4.

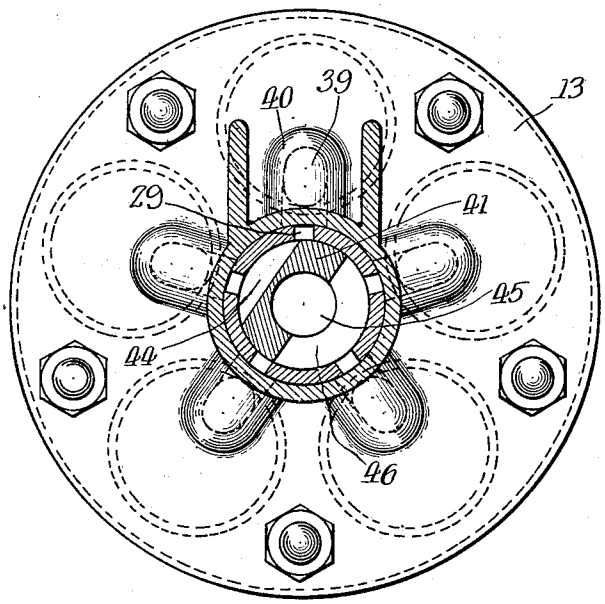


Fig. 5.

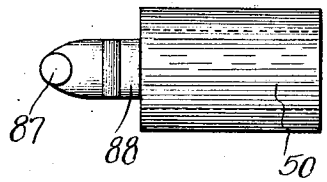


Fig. 6.

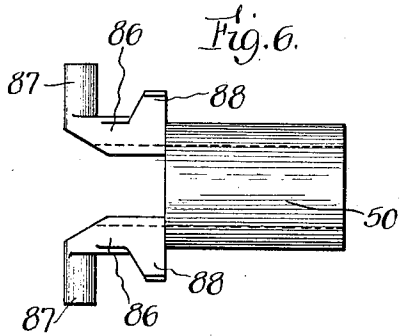


Fig. 7.

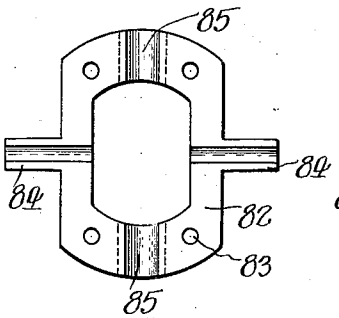
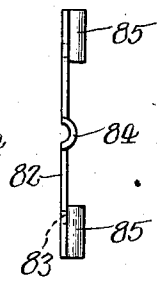


Fig. 8.



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UNITED STATES PATENT OFFICE

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PRESSURE-FLUID MOTOR

Application filed February 16, 1925. Serial No. 9,391.

This invention relates to pressure fluid motors and particularly to motors of the general type of motor disclosed in my copending application Serial No. 743,205 filing date October 13, 1924.

In said application I have described and illustrated a hand held motor device in which a rotary tool is operated by a fluid pressure operated motor comprising a circumferentially arranged group or series of pistons and cylinders acting upon a movable structure which operates to impart a gyratory motion to a pin or arm moving in a conical path. The gyratory motion serves to produce the desired rotation of the tool and likewise to operate a rotating valve member which controls the admission and the exhaust to the cylinders.

It is an object of this invention to provide an advantageous construction for the rotating and gyrating parts of the device whereby to minimize the wear on these parts, and to simplify their manufacture so that the tool may be manufactured on an economical basis.

A particular object is to provide an improved construction for the parts by which gyration is converted into rotation.

Still another object is to provide in such a tool a construction for such parts as are especially subject to wear, which permits their manufacture in the form of sheet metal stampings, thus reducing not only the initial manufacturing cost but also the replacement or maintenance cost of the tool.

Still other and ancillary objects and advantages of the improved structure will be apparent from the ensuing description of the device illustrated in the accompanying drawings in which

Figure 1 represents a longitudinal cross section of the device as a whole.

Fig. 2 is a vertical cross section of the device along the line 2—2 of Fig. 1 showing the arrangement of the movable structure and the universal mounting therefor.

Fig. 3 is a vertical cross section along the line 3—3 of Fig. 1 showing the arrangement of the cylinders and the end of the valve member.

Fig. 4 is a detailed cross section of the valve member on the line 4—4 of Fig. 1.

Figs. 5 and 6 are detailed views of a part of the structure associated with the universal connection.

Figs. 7 and 8 are two views of a plate forming the universal connection.

General description

Referring first to Fig. 1 of the drawings, 10 designates the annular casing of a portable grinder comprising a main or rear section 11 and a front section 12. The rear section is closed by means of a plate 13 with which is rigid a handle 14. Within the rear or main section of the casing is a plurality of motor units arranged in circular series, each comprising a cylinder 15 and a piston 16. The flow of fluid pressure to and from these several motor units is controlled by an automatically operating valve mechanism, generally designated by the numeral 17 and by a manually operable valve in the handle generally designated by the numeral 18. Power impulses imparted to the pistons of the several motor units are successively transmitted by piston rods 19 to a movable structure having a circular series of connections with said piston rods formed in its base plate 20. The movable structure is universely mounted in the fixed body of the device so that it may have a non-rotary wabbling motion as each piston successively acts upon it. The movable structure has a bearing portion 21 axially alined with the base plate 20 and spaced therefrom by a suitable intervening structure adapted to transmit the thrust of the pistons directly to said bearing portion 21. A crank 22 is rigidly mounted on a rotating spindle 23, said crank having a thrust bearing with the bearing portion 21 in a plane inclined to the axis of the spindle 23, the axis of the bearing being so arranged that it passes through the center of the universal mounting of the plate 20.

The present invention relates to the rotary construction within the casing 10. As above pointed out, the rotary construction includes the valve 17, the movable structure including plate 20, bearing portion 21, and the spindle

23 with its crank 22 in rotary relation to the movable structure.

The main or rear section 11 of the tool casing is annular in form and in the present instance is cast to form integral therewith a cylinder block 24 which is bored to receive sleeves forming a circular series of cylinders 15. The annular opening of the cylinder block in part houses the valve mechanism 17.

Integral with the rear plate 13 of the casing is a rearwardly extending tubular portion 27 constituting a hub for the valve mechanism 17 and providing a support to which the handle 14 may be secured, the handle being in this instance shown as formed integrally with the portion 27.

The valve mechanism 17 which I by preference employ, comprises a stationary casing 28 having a series of circumferentially arranged slots forming ports 29 which communicate with passages 39 formed in enlargements 40 integral with the plate 13 (Fig. 1). The passages 39 are inclined forwardly and outwardly and at their forward ends open into the rear ends of the cylinders 15. Within the valve casing 28 is a rotary valve member 41 having at its rear end an annular groove 42 from which a plurality of port holes 43 (Fig. 1) extend forwardly and terminate in a transverse slot 44 formed in the periphery of the valve member, said slot being positioned approximately centrally thereof so as to register successively with the ports 29. The valve member also has a central bore 45 opening at its forward end into a transverse slot 46 located diametrically opposite the slot 44 and also adapted to register successively with the port 29. The annular groove 42 (Fig. 1) communicates at all times with a passage 47 in the handle to which motive fluid is supplied under the control of a manually operable valve 18 so that in the rotation of the valve member, pressure is admitted successively to the circular series of ports 29 by way of the holes or ducts 43 and the transverse slot 44. On the other hand, the bore 45 communicates at its rear end with an exhaust passage 48 extending radially outwardly into an exhaust chamber 49 which is opened to the atmosphere so that as the slot 46 registers successively with the ports 29, communication is established between the cylinders and the atmosphere.

The cylinder block 24 contains a sleeve 50 in which bears a shaft 51 alined with the valve member 41. The end of the valve member 41 is drilled out forming a recess 52 into which the end of shaft 51 projects. The shaft 51 has its end slotted at 53 and the valve member has its end slotted diametrically at 54, the slots being adapted to register so as to receive a locking pin 55 therethrough. A second pair of slots 56 (Fig. 3) is also provided in the valve member to permit varying the axial relation between shaft 51 and the valve member 41 for reversing the direction of rotation. The sleeve 50 stops short in the cylinder block opening leaving an annular space 57 about the shaft 51.

In the present instance the tool spindle 23 and the shaft 51 are axially alined and rigid in structure. Within the front portion 12 of the casing the integral structure contains an offset section hereinabove generally referred to as the crank 22. It is a section of shaft which is made angular to the shaft 51 in such a manner that the axis of the angular section or crank 22 describes a cone in the rotation of the spindle. The spindle 23 bears at one end in the casing 12 in a ball bearing 58. The end 59 of the spindle 23 is rigidly associated as by the key 60 with a collar 61 which is coincident with an extended portion of the shaft 51. The collar 61 bears directly in the bearing 58 and is provided with an annular shoulder 62 abutting the inner race of this bearing. The form of collar 61 provides an irregular shaped strengthening flange in which the bearing shoulder 62 is formed. In Fig. 1 the flange at the bottom is shown of considerable thickness and of considerable radial extent being indicated at 63. Such a construction provides a mass of material which is arranged to counterbalance the weight of the offset section of the shaft, thereby reducing any tendency towards vibration of the device during rotation. In the upper part the flange is thinner and narrower in radial extent and merges into a flange 64 at the end of the angular portion of the shaft thus providing a crank arm for the crank 22. Crank 22 serves as a pivot for the thrust bearing generally referred to as existing between portion 21 and crank 22.

Because of the universal mounting of the movable structure to the fixed portions of the device the movable structure has a wabbling or gyrating motion such that the axis of the movable structure describes a cone and such that there is no rotational relation between said structure and the stationary parts of the device. The gyratory motion is utilized to produce rotation of the spindle 23 by the pivotal relation existing between the coaxial bearing portion 21 and the crank 22.

The pivotal relation is provided by a thrust bearing having a set of bearing balls 65 which run in a ball race 66 formed in flange 64. The complementary race is provided by a dished annular ring 67 preferably of sheet metal supported in elevated relation to the plate 20 by a spider construction 68 extending to and secured to plate 20 by the bolts 69 and nuts 70 at each arm of the spider.

The universal relation is provided by a universal connection to be presently described operating between the plate 20 and the sleeve 50 hereinbefore described as set into the cylinder block 24 and providing a fixed bearing

for shaft 51. The plate 20 is constructed to receive the thrust of the pistons 16 and the arms of the spider transmit this thrust directly to the thrust bearing through the balls 65. In the present instance five of such pistons are provided, each having a ball and socket connection with the wabbling plate 20. Plate 20 is pentagonal in form and is provided at each apex with a semi-spherical depression 71. The plate is apertured at the center for the passage therethrough of the crank 22 and for the mounting of the universal connection. A complementary plate 72 with upturned edges 73 and a series of spherical flanges 74 fits over the plate 20 and is secured thereto by the nuts and bolts 69 and 70 which secure the spider arms 68 onto plate 20. Plate 72 is apertured similar to plate 20. The two plates together cause registration of the spherical depressions 71 and the spherical flanges 74 to form a socket for ball 75 on each piston rod 19. Plate 72 is slotted at each apex as shown at 76 to permit insertion of the piston rod 19.

The universal connection has one pivotal mounting in the plate 20. Thus, each of plates 20 and 72 have registering depressions 77 and 78 respectively associated to form a pivot bearing and also diametrically opposite depressions 79 and 80 respectively as shown in Figs. 1 and 2. A yoke member 81 (Fig. 2) is pivoted in said depressions. Yoke member 81 comprises two similar plates 82 (Figs. 7 and 8) of sheet metal riveted together at 83. Semi-cylindrical projections 84 form trunnions which are adapted to be placed in the depressions in the plates 20 and 72. Also, there are provided semi-cylindrical depressions 85 in the plates 82 lying at right angles to the projections 84. These depressions 85 form bearings for another part of the universal connection.

The other mounting of the universal connection comprises a pair of trunnions rigid with the cylinder block 24 and engaging the depressions 85. This structure is preferably made integrally with the sleeve 50 which is provided with diametrically arranged projections 86 terminating in coaxial trunnions 87. Radial lugs 88 are provided which fit into recesses therefor in the cylinder block 24 to hold the pivot structure and the sleeve structure 50 rigid therewith. As described in the above mentioned application, an air duct is provided for air leaking into the casing. The passage of air through the duct is adapted to cool the rotating parts. The duct is preferably formed by the passage 88 in crank 22, passage 89 in shaft 51 and radial passage 90 in the shaft 51 communicating with the annular space 57 and an outlet passage 91 through cylinder block 24 and plate 13.

By the above described construction it is possible to construct a device of the class described having but one set of ball bearings in the bearing between the angular shafting and the gyrating structure. As such bearings are subject to great pressure and high speed this is an important improvement in such devices. Furthermore the present construction is such that the parts are reduced in number and are simplified in form thus making them capable of economic manufacture as sheet metal stampings. Such a structure reduces the machining of parts heretofore required for other constructions and permits the manufacture of an efficient device at much less cost than heretofore. Another feature of the present construction is the provision of replaceable wearing parts which have a simple structure and which may easily be procured at small expense for renewal when necessary. This makes it possible for the user of the tool to maintain his device in good operative condition by being able to secure at limited expense the replaceable wearing parts.

I claim as my invention:

1. A pressure fluid actuated tool comprising, in combination, a spindle having a crank portion rigid therewith, a gyratory member comprising a plate mounted to turn on two axes intersecting at a point lying in the axis of said spindle and spaced from the arm of said crank, a cupped member supported upon said plate in spaced relation thereto and forming a ball-race, said crank also having a ball-race thereon in opposed relation to said member, and bearing balls entered between said races.

2. A pressure fluid actuated tool comprising, in combination with a plurality of motor units arranged in circular series, a plate mounted to turn on intersecting axes with the point of intersection lying in the axis of said series of units and arranged to be swung on said intersecting axes by said units, a part to be driven having a crank arm associated therewith, said plate and crank arm occupying at all times a parallel relation, and means providing a thrust bearing between said plate and said crank arm comprising a cupped member mounted on said plate in spaced relation thereto, and bearing balls interposed between said cupped member and the crank arm.

3. A pressure fluid actuated tool comprising a plurality of motor units arranged in circular series, a universally mounted pressure member operatively associated with said motor units, a tool spindle, a part connected with said spindle and disposed on one side of its axis, and means for translating gyratory motion imparted to said pressure member into rotary motion in said part comprising a member rigidly supported upon the pressure member in parallel relation thereto but spaced a substantial distance therefrom, said member being shaped to provide one race of

a thrust bearing of which the other race is formed on said part, and bearing balls interposed in said races.

4. In a device of the class described, in combination, a housing, a gyratory rotary shaft, a gyratory non-rotary structure pivotally related to said shaft, said shaft having a ball race formed therein facing inwardly toward the axis of rotation, said structure having a complementary ball race formed therein facing outwardly from said axis, a series of balls between said two races, and a universal connection between said structure and said housing.

5. In a device of the character described, in combination, a housing, a gyratory rotary shaft, a gyrating non-rotary structure associated with said shaft, said structure comprising a substantially annular member arranged perpendicularly to the shaft, means within the opening of the member to mount it universally on the housing about the apex of gyration of the shaft, a plurality of circumferentially arranged pistons acting on said member on one side thereof, and a bearing member about said shaft beyond the annular member on the side opposite to said pistons, and supporting means rigidly connecting said annular member and said bearing member.

6. In a device of the class described, a non-rotary gyratory structure adapted to be acted upon at one side by a plurality of circumferentially arranged pistons comprising a member providing in a single plane a pressure receiving part for each piston, a second member spaced from the first on the side opposite the pistons, means to mount the structure universally about the apex of gyration, a rotary shaft adapted to gyrate about said apex, and a bearing between said second member and said shaft.

7. A gyrating structure for a device of the class described, said structure having parts adapted to be formed as stampings from sheet metal comprising a plate having a plurality of hemispherical depressions therein to receive piston rods in a ball and socket relation, a complementary plate having openings therein with spherically curved retaining flanges forming a spherical socket with the depressions of the first plate, an upstanding spider having a cupped body portion with a circular opening therein and having legs adapted to support said body portion above the plates, and means to secure together said two plates and said legs.

8. A gyrating structure for a device of the class described, said structure having parts adapted to be formed as stampings from sheet metal comprising a plate having a plurality of hemispherical depressions therein to receive piston rods in a ball and socket relation, a complementary plate having openings therein with spherically curved retaining flanges forming a spherical socket with the depressions of the first plate, an upstanding spider having a cupped body portion with a circular opening therein and having legs adapted to support said body portion above the plates, and means to secure together said two plates and said legs, each of said plates having a central opening therein and opposing depressions on opposite sides of said openings adapted to receive a pair of pivot pins for support thereby.

9. A universal support for a gyratory member in a device of the character described, comprising, in combination, two metal plates of similar size and shape, each having a flat face, said plates being secured together with the flat faces abutting, and each plate having semi-cylindrical depressions therein on opposite sides adapted to form alined pivot bearings, each plate having also semi-cylindrical extensions being adapted to form pivot pins for the member.

10. A universal support for a gyratory member of the character described, comprising, in combination, two similar plates secured together in opposed relation, said plates having similarly arranged projections and depressions so that when secured together, said depressions form pivot bearings and said extensions form pivots at right angles to the pivot bearings.

In testimony whereof, I have hereunto affixed my signature.

ERNEST H. SHAFF.