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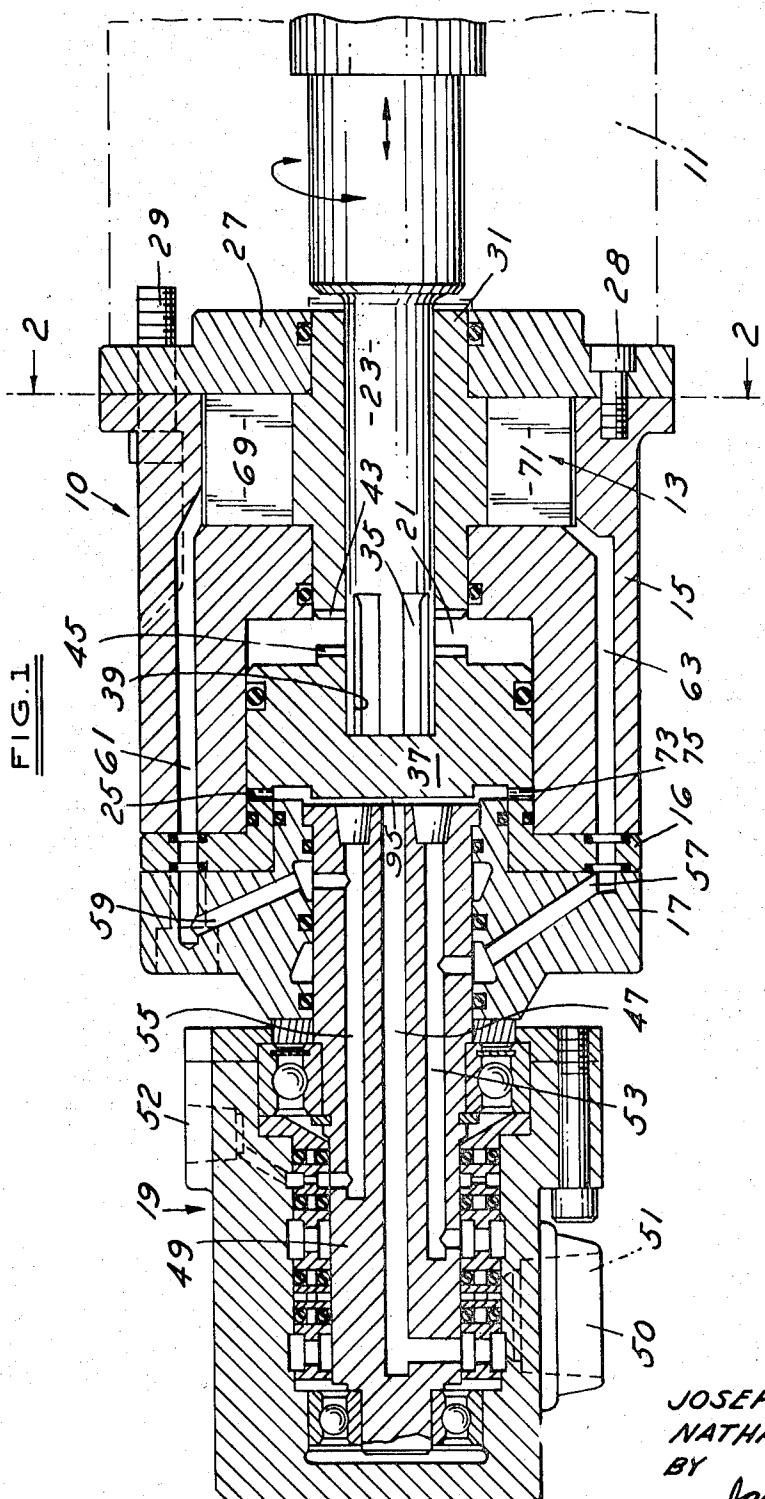
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3,620,131

ROTARY-LINEAR DUAL-DIRECTIONAL ROTATING ACTUATOR

Filed Dec. 4, 1969

3 Sheets-Sheet 1



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FIG. 2

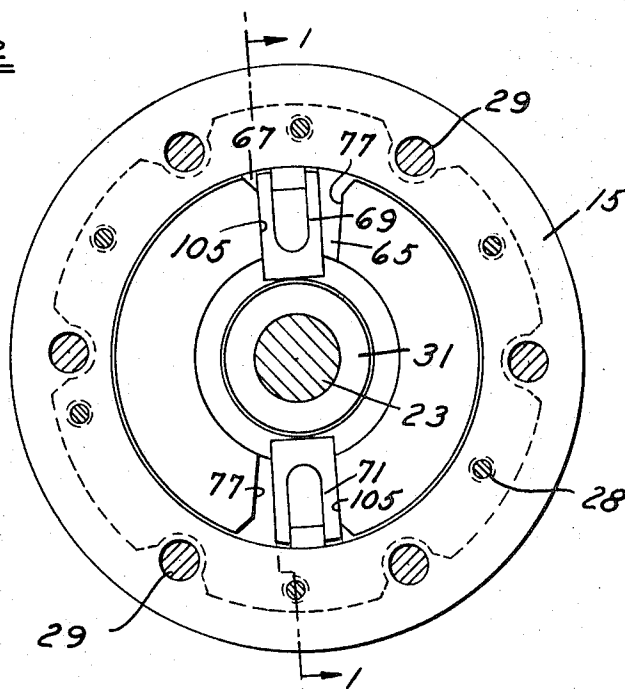
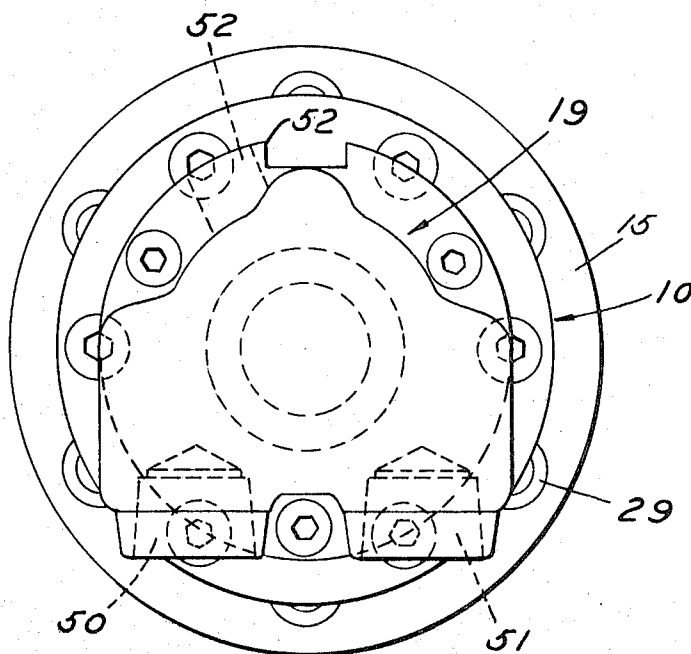


FIG. 3



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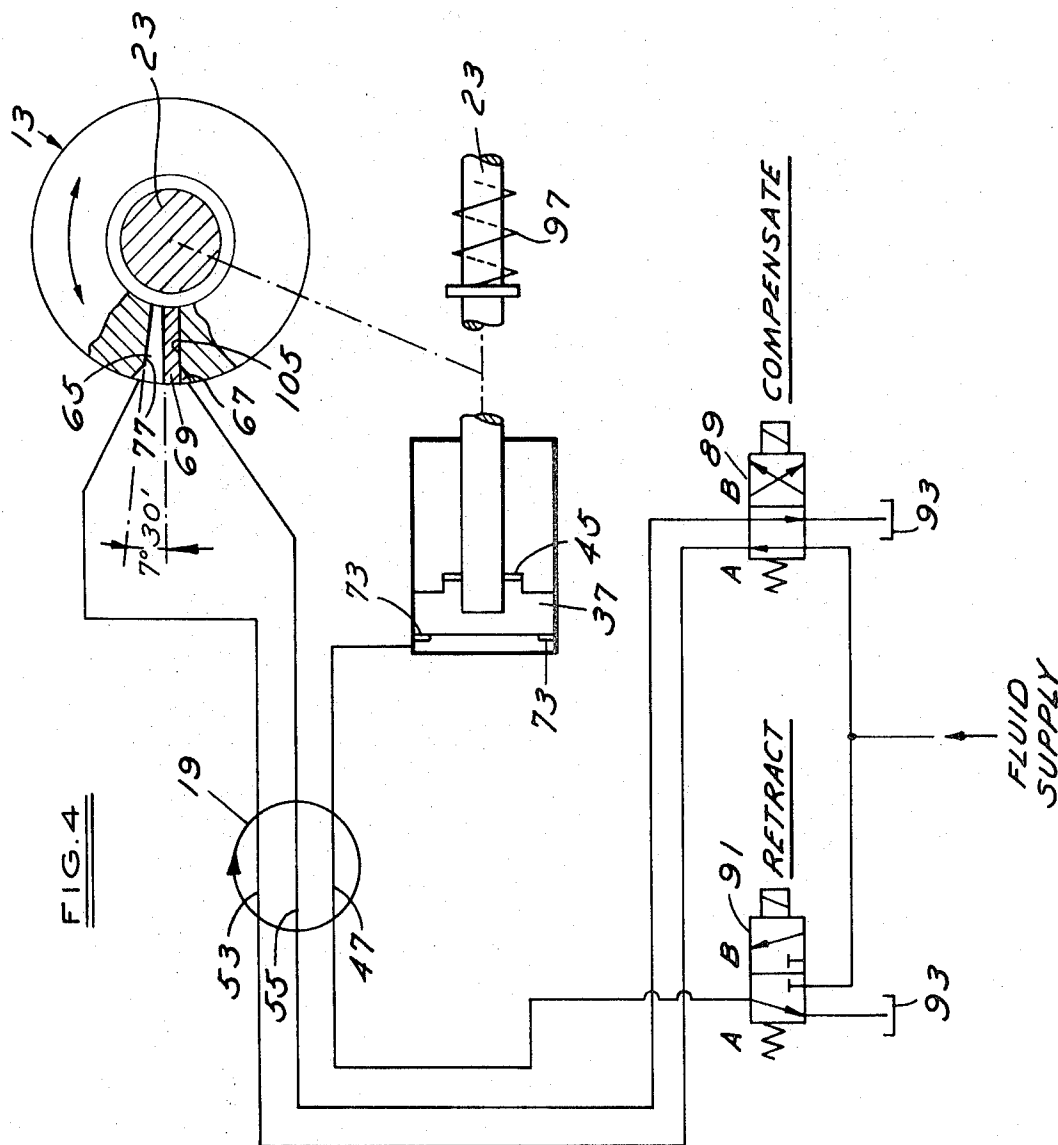


FIG. 4

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ROTARY-LINEAR DUAL-DIRECTIONAL ROTATING ACTUATOR

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1 Claim

ABSTRACT OF THE DISCLOSURE

A rotary-linear actuator to permit retraction of a cutting tool in a boring bar and size compensation of the cutting tool in either clockwise or counterclockwise direction.

BACKGROUND OF THE INVENTION

(1) Field of the invention

This invention relates to an improved version of fluid control devices of the type shown in Drake Pat. No. 3,215,046, issued Nov. 2, 1965, and Ludwig et al. Pat. No. 3,793,623, issued May 28, 1957, in which a plurality of circumferentially disposed vanes mounted on a shaft are partially rotated by hydraulic fluid to selectively rotate the shaft in increments. As shown in Griswold et al., Pat. No. 3,391,585, issued July 9, 1968, on a Boring Spindle, the intermittent rotary motion of the actuator causes a rotary index of the cam which is mounted to an actuating bar and which action changes tool size. This invention combines the rotary fluid control and the rotary indexing of the cam and is particularly concerned with the linear and/or rotary movement of the actuating bar in either clockwise or counterclockwise direction.

(2) Description of the prior art

It is known to selectively hold and release a shaft by means of devices utilizing a releasing means. These releasing means may comprise electromagnetic clutches, pressure rollers, or vane type such as disclosed in the above noted patents. Moreover, in the copending patent application, S.N. 861,109, filed Sept. 25, 1969 on a Rotary-Linear Actuator is directed to a single direction.

SUMMARY OF THE INVENTION

According to the present invention, a rotating rotary actuator and piston are mounted to a rotatable spindle and connected to a hydraulic pressure source through a rotary coupling. Piston actuation causes the actuating bar to move in a linear direction thereby causing the connected tapered cam to retract the cutting tool. A dual directional clutch means permits dual direction rotary motion of a cam which action changes tool size, either during spindle rotation or when the spindle is not rotating.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is partial cross-sectional view of the rotary actuator assembly, and taken along line 1—1 of FIG. 2;

FIG. 2 is partial cross-sectional view of the rotary vane means, and taken along a line 2—2 of FIG. 1;

FIG. 3 is an end view of the rotary linear actuator;

FIG. 4 is a schematic diagram showing one of the arrangements for supplying the fluid, air or hydraulic, to the actuators.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The cutting tool of a precision boring spindle requires a means for retracting the tool after the boring operation has been finished in order to avoid tool marks during the return stroke of the spindle. It is also desirable to provide

a means for a controlled bidirectional radial motion of the cutting tool in order to compensate for the wear of the tool, or adjust for size, thus holding the part dimensions within the desired size or tolerance limits.

The purpose of the following described invention is to provide a compact rotating unit capable of providing both the retract as well as the bidirectional compensating motions as described in the foregoing. The compensating and retracting motions are accomplished during spindle rotation at normal operating speeds. This rotating retracting and bidirectional compensating unit will also operate when the spindle rotation is stationary. It is intended for any application requiring controlled linear and rotational motion of any practical length and/or specific rotary movement within one full revolution such as the device patented in Griswold et al. Pat. No. 3,391,585, and in copending patent application S.N. 861,109, filed on Sept. 25, 1969.

Referring to FIG. 1, the actuator assembly 10 is shown in the position it is mounted to the pulley 11 of a precision boring spindle.

The embodiment of the actuator assembly 10 is comprised of a rotary actuator unit 13, a body 15, a manifold 17, a rotary union 19, a first toothed clutch means 21, and actuating or draw bar 23, and a second toothed clutch means 25.

On the right end of the body 15, a flange 27 is secured thereto by bolts 28, and with the use of bolts 29 serves as a means of mounting the complete assembly to the pulley 11, and, at the same time, provides a coaxial alignment with the spindle. A sleeve 31 connected to vanes 69 and 71 axially receives actuating bar 23 (this is element 27 in copending patent application S. N. 861,109, filed on Sept. 25, 1969 in the name of Joseph Nitkiewicz; assigned to the assignee of record).

The actuating bar 23 includes splines 35 on the end thereof, which coast with internal splines 39 on piston 37, for reasons to be explained herein.

The rotary actuator assembly unit 13 is mounted for rotary movement only. That is, vanes 69 and 71 are connected to the sleeve 31 and toothed clutch teeth 43 are circumferentially arranged on the internal end of said sleeve 31.

When the rotary actuator assembly 13 is indexed either clockwise or counterclockwise, the toothed clutch teeth 43 on the sleeve 31 is adapted to engage toothed clutch teeth 45 on piston 37 by movement of the piston 37 toward the right, as in FIG. 1. The piston movement is effected by movement of fluid in passage 47 of rotatable shaft 49 in rotary union 19. The shaft 49 is rotating with the actuator assembly 10, while the rotary union 19 is stationary, thus allowing stationary fluid supply and drain lines to be connected to the ports 50, 51, and 52. The fluid is transmitted by means of fluid channels 47, 53, and 55 to operate the rotary-linear actuator means. The rotary motion is accomplished as follows: fluid flows in passages 57 and 59 in manifold 17, through channels 61 and 63 of body 15 and enters the chambers 65 and 67, respectively, of the rotary actuator unit 13. Depending on the direction required, vanes 69 and 71 will move in increments of 7°30', see FIG. 4. Since this is a closed system, while one side of the vane is being moved by the fluid, either clockwise or counterclockwise, the fluid on the other side of the vane is being drained to reservoir 93. The piston 37 is adapted for forward or retract motion, as well as rotational motion. That is, the forward and retract motion of the piston 37 is to provide the "tonking" feature, as disclosed in the above noted Griswold et al. patent. However, the piston has an additional feature in that it provides the rotational movement of the actuating bar necessary for compensation of the cutting tool. This is accomplished when the piston 37 is moved toward the right,

as in FIG. 1, causing toothed clutch teeth 45 on piston 37 to engage the toothed clutch teeth 43 on sleeve 31. Movement of the vanes 69 and 71, either clockwise or counterclockwise effects movement of sleeve 31. Axial movement of piston 37 engages first toothed clutch means 21. Thus rotational movement of sleeve 31 causes rotational movement of piston 37 and through splines 35, 39 causes rotational movement to actuating bar 23, and rotation of actuating bar 23 will result in indexing the cutting tool in a manner disclosed in the Griswold et al. patent; i.e., moving the cutting tool to a new position to compensate for wear on the cutting tool, or to adjust the tool for different bore sizes. The spline connection between the actuating bar 23 and piston 37 ensures a positive torque transmitting capability. The toothed clutch teeth 45 on piston 37 must be engaged with the toothed clutch teeth 43 on sleeve 31 whenever a compensating type of rotary motion is desired; however, it must be disengaged when the rotary actuator is being reset for the next desired indexing cycle. Therefore, each indexing type of motion is accomplished in three steps: the first step is to engage the toothed clutch teeth 43 and 45; i.e., engage the first clutch means 21; the second step is to perform the compensating type of rotary motion, either clockwise or counterclockwise; and finally to disengage the first clutch means 21 to reset the rotary actuator for the next compensatory cycle.

When the piston is moved to its most rearward position, or left as shown in FIG. 1, the toothed clutch teeth 73 on the other side of piston 37, contacts the toothed clutch teeth 75 on adjusting bushing 16 which is abutting manifold 17. The manifold 17, adjusting bushing 16, body 15, and flange 27 comprise the integral actuator assembly unit 10, which is connected to pulley 11. As the pulley 11 rotates the actuator assembly unit 10, the rotational movement is imparted to the shaft 23, through the second clutch means 25 and splines 35, and 39 effects coordinated rotation of the cutting tool and actuating bar.

OPERATION

(A) Retract

FIG. 4 shows a schematic representation of the invention. Valves 89 and 91 are two-position spring-offset directional valves, which can be shifted in either one of positions A or B. When both directional valves 89 and 91 are in position A, as shown, both fluid passages 47 and 55 are connected to reservoir 93. The linear actuator is in the normal position; and the rotary actuator is positively retained against stop 105 through positive fluid pressure in fluid passage 53. Consequently, the cutter is in its normal working or cutting position. By energizing the right side of valve 91, the spool is shifted to position B, and fluid under pressure is being supplied to port 50, through channel 47 in rotatable shaft 49 of coupling 19, to forward face area 95 of piston 37, causing piston 37 to move forward. Moving piston 37 forward pushes the actuating bar 23 and consequently retracts the cutter radially. The cutter will be kept in this retracted position until it is removed from the bore or other structural obstructions of the workpiece. Deenergizing valve 91 moves the spring-offset spool back to position A thereby connecting line 47 to reservoir. The piston 37 will return to the normal position through the force of the spring 97 acting on returning actuating bar 23.

(B) Rotary motion

Energizing valve 89, the spool will be shifted to position B and fluid under pressure will be supplied to port 52, through channels 55, 59, and 61 to one side of vanes 69 and 71. The pressurized fluid will force the vane 69 to rotate until it reaches a stop 77 signifying a partial movement of a preset amount. The rotary actuator is now set for a counterclockwise indexing motion. The piston 37 must be engaged with the rotary actuator sleeve 31 when-

ever a compensating type rotary motion of the draw bar 23 is necessary, and it must be disengaged when the rotary actuator is being reset for the next indexing cycle. Consequently, valve 91 is energized, thereby shifting its spool to position B, allowing fluid under pressure to flow through channel 47 of rotatable shaft 49 to forward area 95 of piston 37, causing the piston 37 to move forward thereby retracting the cutter and engaging first toothed clutch means 21; that is, allowing the toothed clutch teeth 45 to engage the toothed clutch teeth 43 on the rotary actuator sleeve 31. With the piston 37 in the forward direction, and toothed clutch means 21 engaged, valve 89 is deenergized, allowing the spool to be shifted to position A. Consequently, fluid in chamber 67 will now be connected to the reservoir 93, and the other side of vanes 69 and 71 is supplied by pressurized fluid by way of port 51, channels 53, 57, and 63 to rotate vanes 69 and 71. Rotation of vanes 69 and 71 is for compensating actuating bar 23 through rotary actuator sleeve 31, first toothed clutch means 21, piston 37, and splines 35, 39. This rotation is thus transformed into a radial motion of the cutter as required to compensate for wear of the tool, or to adjust for varied bore sizes.

Deenergizing valve 91 allows the spool to shift back to position A, connecting channel 47 to reservoir, thus causing piston 37 to return to its normal position, through the force of spring 97 acting on actuating bar 23. At the same time that the toothed clutch teeth 43 and 45 are disengaged, the tool cutter is expanded to the new compensated or adjusted radial position.

For rotary compensating motion in a clockwise direction the following is applied. The vane 69 resting on stop 105, is already set for a clockwise compensating motion, therefore, no resetting cycle is necessary. Valve 91 is energized, allowing the piston 37 to move forward and engage toothed clutch teeth 43 and 45. Then the valve 89 is energized allowing fluid under pressure to flow to one side of vane 69, causing the vanes to be rotated in a clockwise direction until it reaches stop 77. Thus the draw bar is rotated simultaneously with the rotation of the vanes as explained herein above.

With valve 89 being kept energized, valve 91 is deenergized allowing the fluid to return to reservoir and the piston 37 to return to its normal position. Thus, the tool cutter is expanded to the new adjusted radial position. After the piston is retracted, valve 89 is deenergized causing the fluid from the chamber 65 of rotary actuator 13 to return to reservoir and the vanes 69 and 71 to return to its original position by force of fluid flowing on the other side of vanes 69 and 71. This resets the rotary actuator unit to its normal position.

The foregoing cycles can be performed either manually or automatically generated command signals. Moreover, it is to be understood that the device hereinabove described will function either rotatively or when stationary.

What is claimed is:

1. A rotary-linear actuator adapted to retract or compensate a cutting tool in either direction on a precision boring spindle during spindle rotation, comprising:

(A) rotatable actuator means, said rotatable actuator means comprising:

(1) a rotatable cylindrical housing, said rotatable cylindrical housing having;

(a) a manifold, said manifold having a bore for receiving a rotatable shaft;

(b) a cylindrical body, said cylindrical body having a bore with a piston slidably mounted therein;

(1) one end of said piston having a recessed bore extending axially approximately to the midpoint of its thickness;

(2) said recessed bore having internal spline teeth thereon;

(3) first toothed clutch teeth mounted circumferentially on said one end of

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said piston around said recessed bore;
and

(4) second toothed clutch teeth mounted
circumferentially on the other end of
said piston,

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(c) a rotary actuator unit; said rotary actu-
ator unit having vane means connected to
a sleeve having a bore; and

(d) a draw bar, said draw bar having spline
teeth on one end, mounted in said bore of
said sleeve, said spline teeth on said draw
bar engaging said interlan spline teeth of
said piston;

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(B) a stationary cylindrical coupling mounted on the
end of said cylindrical rotatable actuator means and
having inlet and outlet fluid ports connected to said
rotatable shaft interconnecting said manifold and said
coupling whereby, while in motion caused by rota-

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tion of a pulley means, said draw bar is adapted to be
additionally moved by said vanes in either direction,
thus effecting incremental radial movement of a tool
cutter in either direction on the end of said draw bar.

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U.S. Cl. X.R.

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