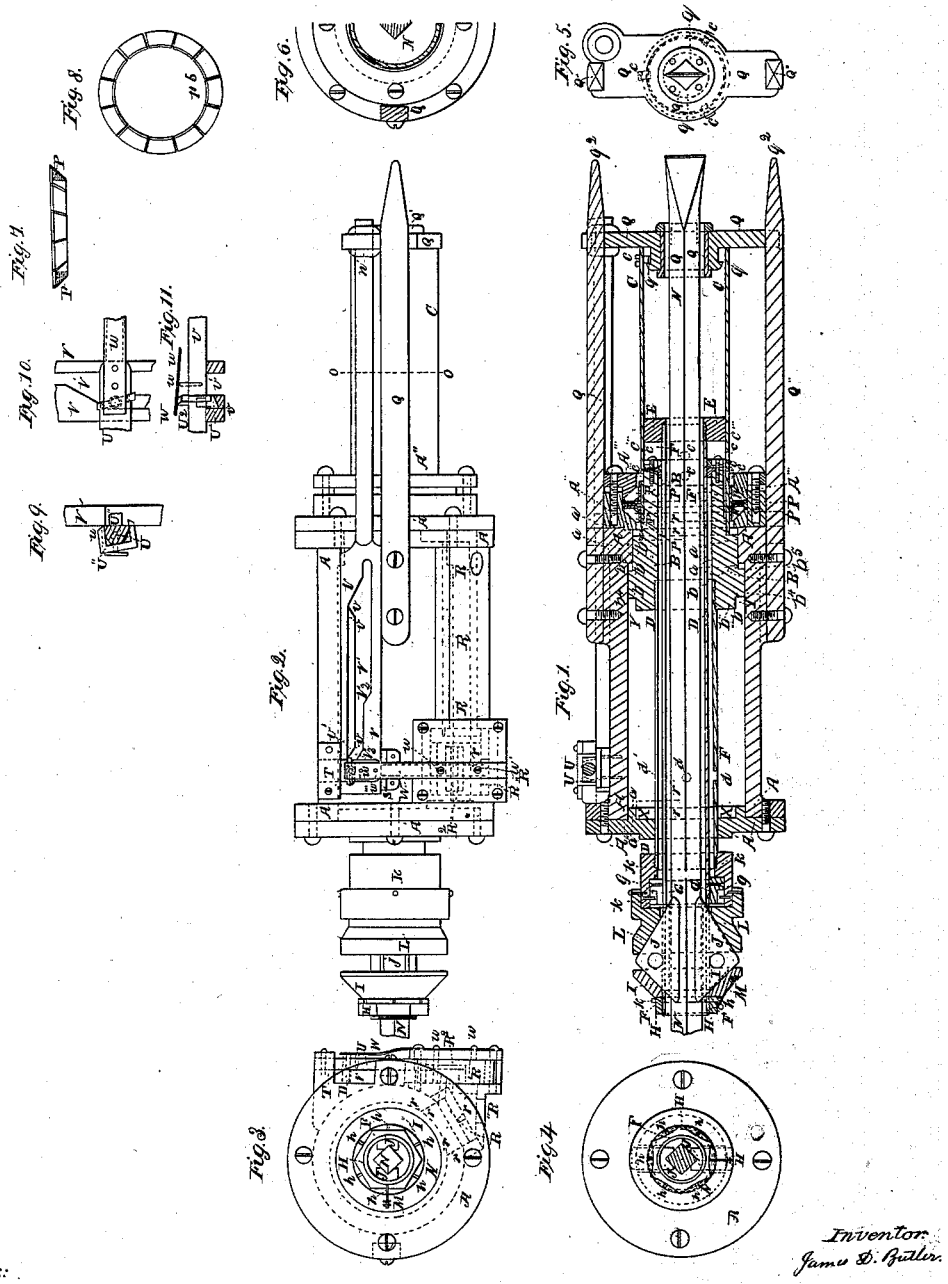
J. D. Butler,

Steam Rock-Drill.

No. 47,390. Patented Apr. 25, 1865.



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JAMES D. BUTLER, OF NORTH ADAMS, MASSACHUSETTS.

IMPROVED ENGINE FOR OPERATING ROCK-DRILLS.

Specification forming part of Letters Patent No. **17,393**, dated April 25, 1835.

To all whom it may concern:

Be it known that I, JAMES D. BUTLER, of North Adams, in the county of Berkshire and State of Massachusetts, have made an invention having reference to rock-drilling engines to be worked by compressed air, steam, or gas; and I do hereby declare the same to be fully described in the following specification and represented in the accompanying drawings.

The engine is of the class in which the drill, by means of a reciprocating piston, is alternately thrown against and withdrawn from the rock to be drilled.

The machine is represented as adapted for the use of compressed air, which by means of a conduit is to be led into it from the reservoir in which such air may be confined.

In the accompanying drawings, Figure 1 represents a longitudinal section of the machine; Fig. 2, a side elevation, and Fig. 3 an end view, of it. Fig. 4 is an end view of its cylinder-cover, piston-rods, &c. Fig. 5 is an end view of its cross-head and slides. Fig. 6 is a transverse section taken through the line 0 0 of Fig. 2. Figs. 7 and 8 are detailed views of the annular packing-segments; and Figs. 9, 10, and 11 represent detailed projections of the spring catch and attachments for the main-valve stem.

In Figs. 1, 2, 3, 4, 5, and 6, A represents the engine-cylinder, having within it a piston-head, B, from opposite ends of which two tubular piston-rods, C D, are projected through the heads of the cylinder. Within the hollow rod C is an auxiliary piston, E, from which runs a tubular piston-rod, F, which goes axially within the hollow rod D and through another piston, G, to which it is fastened, a nut, H, being screwed on such piston-rod F. A hollow cone, I, arranged on the rod F, bears against the nut H. There is a packing box, b^*, around the piston-rod F, and in the main piston B. The rod F has lateral openings made through it for reception of certain gibs J J, which are arranged as shown in Figs. 1, 3, and 4. The piston G works in a short cylinder, K, which is fastened to the hollow piston-rod D, and by means of such rod is also connected to the main piston B. A hollow cone, L, surrounding the gibs J J, is fixed to the end of the cylinder K and arranged relatively thereto, as represented in Fig. 1.

In order to prevent the two cones I L from revolving about their axis with reference to each other, the two gibs J J may be extended a short distance into grooves made in such cones. The piston G and its rod F should be kept from revolving in the cylinder K and rod B by means of pins *k k*, extended from the cylinder and into slots *g g* made in the piston G. Upon the exterior of the cone I is a spring, M, which takes into one of a series, *h*, made in the nut H, as shown in Figs. 1, 3, and 4. In the piston-rod D are holes *d*, opening into the annular space between the rods D and F. In the piston-rod C there are holes *c c'*, opening into the annular space between the rods or tubes C and F.

N is a drill which passes between the gibs J J, and also through the rods C and F, and a collar, Q', carried by a cross-head, Q. The two points or places of support of the said drill are between the gibs and the cross-head collar. In the collar the drill bears at two opposite corners, *q'*, (see Fig. 5,) the other two being somewhat cut away to allow the wings *n* of the cutting-edge of the drill to pass through it from the farther end of the machine at which the drill is inserted. The gibs J, when the engine is in operation, open and close alternately upon the drill, forming, when closed so tightly upon it that it shall not slip between them, a connection between the main piston-head and the drill, through the cone L, the cylinder K, and the piston-rod D, that the drill shall partake of the motion of the piston-head. The cylinder A, from *a* to *a'*, is reduced in diameter of bore, and there receives a part, *b b'*, of the main piston which fits to it. The cylinder-cover A' is hollowed out at X to a diameter less than that of the main part of the cylinder, and to the proper depth, *a'' a'''*, the end *b'' b'''* of the main piston being turned down to fit into the space X.

In the cylinder-head A'' is the packing-box for the piston-rod C. There are two pieces or rings of leather or other suitable material, *p p'* and *p'' p'''*, each in the shape of a ring, with one portion turned over to form a sort of flange. They encompass the piston-rod, and have between their flanged ends another piece of leather or suitable material, p^4, which bears against the outer shell, A'', of the packing-box. Each of the leather rings is supported by sets of wedges or segments of one of two conical rings, P P', one of which is fully

shown in Figs. 7 and 8. These segments are placed within hollow cones, one of which is in the packing-box proper, and the other in the follower A'''. The bringing up of the follower upon the packing-box acts through the segments to squeeze the leather rings against the piston-rod and crowd their flanges together, and on the packing p^4, between these flanges, forcing it out against the shell and making the box tight all around. The packing p^4 is introduced to prevent leakage around the outside of the segments. The segments are set with small spaces p^5, (see Figs. 7 and 8,) between their ends, such spaces being necessary in order to allow the contraction of the segments into a smaller circle as the packing is set up. As they are represented, the holes in the cylinder cover and in the follower for reception of the piston-rod C are formed considerably larger in diameter than that of the said piston-rod. Thus the rod will be guided by the packing simply. It may be thought best to have the said holes so made that their sides shall be in contact with the rod throughout the whole circumference, or in spaces at regular intervals on it, so that the rod may be guided by the holes or parts thereof. The other piston-rods may be packed in the same way as the above, or all may be packed in any of the known ways. The outer end of the piston-rod, C, is brought up against the cross-head Q, and kept there by three screws, *c*, (see Figs. 1 and 5,) which screw into the rod, and project in rear of a shoulder, *q*, of the cross-head.

By inspection of Fig. 1 it will be seen that the part of the cross-head which projects into the piston-rod has a diameter somewhat less than that of the bore of the rod; also, that the inner ends of the screws *c* do not touch the cross-head, so that there is allowed a free transverse motion between the piston-rod and cross-head, while yet no motion is permitted in the direction of the length of the piston, and the cross-head is kept perpendicular to the axis of the rod. The part of the cross-head to which the attachment of the piston-rod is made being cylindrical, a freedom of motion between the two about the axis of the rod is also secured. The cross-head runs upon guides Q, attached firmly to the main cylinder of the engine. The collar Q' fits in the cross-head, but is free to turn in it.

V is a valve-stem (see Figs. 1, 2, 3, 9, 10, and 11) which has in it a pin, U', with a beveled end, as shown, projecting into the slot V' in the slide-bar V. This slide-bar is attached at *u'* to the cross-head of the engine, and reciprocates with it. It is guided by the blocks S and T, moving between them. Across the valve-stem U is put the yoke U'', whose two arms are let into grooves in the stem where they embrace it. A spring, W, fastened at *w*, and *w'* to the valve-chest bears upon the yoke U''. In the spring are two holes, *w''* *w'''*, into either of which the pin U on the valve-stem will enter. In the slide-bar V is a ledge, *v v*, whose upper surface is beveled to the same angle as the end of the pin U', the same being as shown in Fig. 11. Its outer edge is at a depth from the face U'', less than that to which the longer side of the pin reaches, while its lower corner is at a depth just exceeding the length of the pin sufficient to allow the proper clearance.

The hole for the admission of the compressed air to the machine is represented at R in Fig. 1. From this point there is a free passage to one end of the cylinder through the port *r r*, (see Fig. 3,) so that a constant pressure is exerted upon the end $b^5\ b'\ b'\ b^5$ of the piston. The constant-pressure space in the cylinder with the piston in the position shown is represented by the blue tinting of Fig. 1. From R the passage R' runs into the valve chest R. In this chest is a common slide-valve, R, acting to alternately admit the compressed air from the chest into the port *r'*, and through it into the cylinder and upon the end $b^4\ b''\ b''\ b^4$ of the piston, and to discharge it through the exhaust-passage *r'''* and R'' into the atmosphere. The area of the end $b^4\ b''\ b''\ b^4$ is made larger than that of the end $b^5\ b'\ b'\ b^5$. The pressure upon the end of $b^5\ b'\ b'\ b^5$, being constant, will move the piston before it when there is no pressure upon $b^4\ b''\ b''\ b^4$; but when pressure is exerted upon $b^4\ b''\ b''\ b^4$ it will drive the piston before it in opposition to the constant pressure. The area of $b^4\ b''\ b''\ b^4$ effective for the moving of the piston is the difference between its full area and that of $b^5\ b'\ b'\ b^5$. Thus by having a constant pressure on one end of the piston and an intermittent one on the larger opposite end a reciprocating motion is given.

In the working of the machine an intermittent rotary feed motion about its axis is given to the drill as has been usual in drilling-engines heretofore used. The drill being held firmly at times by the gibs J, it is sufficient at these times to give to the piston and its attachments such a rotary motion as is required for the drill. This is accomplished by the ordinary means of a ratchet and pawl, the ratchet used in this machine being fixed on the cylinder K.

In using the machine it is placed with the cross-head end toward the rock to be drilled. The points q^2 of the slides may be set against the rock, so as to give a point of support for one end of the machine, while the other end may be held by chains or any convenient fastening.

When desired, the machine may be entirely supported by being bolted to a frame, which shall be brought up near to the face of the rock.

The machine may be set in any position—horizontal, vertical, or oblique.

The machine being in place, the drill may be inserted from the end of the machine that is farther from the rock, through the gibs, the hollow piston-rods and the cross-head collar.

The nut H is turned nearly off, so as to allow the cones to separate and the gibs to open widely, so that there may be abundant room for the drill to pass through easily. When the drill has been inserted, the nut is turned as far up as possible, thus tightening the gibs upon the drill. From this position it is to be turned back as much as may be thought best to allow a little play between the gibs and cones and the loosening of the gibs upon the drill. The spring M is then snapped into one of the notches *h*, thus holding the nut in place and preventing it from turning and shaking off from the rod. As the cone I simply bears against the nut H without being attached to it and the hole in the cone through which the rod passes is considerably larger than the rod, the cone is allowed a free transverse motion within certain limits with reference to the rod. The effect of this arrangement is that, while the cone may be thrown to one side or the other through irregularity in the gibs, the rod is relieved from transverse strain, which would tend to cause wear in and leakage around the pistons G E, attached to it.

In the drawings the piston is represented near one end of a full stroke. The edge of the drill is supposed to be against the rock. The gibs are lying loosely between the hollow cones and upon the drill, so that the piston will move along the drill without taking it with it. When, however, the edges c'' of the hole *c* pass the edge *p* of the packing in the packing box, the compressed air rushes through these holes into the annular space between C and F, and, acting upon the piston E, gives motion to it in the direction toward the cross-head, and through it to the rod F, the piston G, the nut H, and the cone I. This cone I being drawn toward the cone L, the gibs are crowded upon the drill, taking a firm hold upon it. The drill, being thus seized, takes the motion of the main piston by which it is withdrawn from the rock. This firm hold upon the drill continues until in the return-stroke the holes *d* in the piston-rod D come through the packing-box in the cylinder-head into the cylinder, which is now filled with the compressed air. Through these holes the air passes into the annular space between the rods D and F, and through it into the cylinder K, acting upon the piston G. This piston, it will be remembered, is connected through the tube F with the piston E, which is of a larger area, and consequently takes a greater pressure. The pressure upon the two pistons being opposite, the effect of that upon G is to neutralize in part the action of that on E, whereby the grasp of the gibs upon the drill is somewhat eased. The piston E may be called the "main-clutch piston" and G the "counter-clutch piston." The light hold of the clutches upon the drill is maintained until the edges c''' of the holes c' pass the edge p''' of the packing, when the compressed air escapes into the atmosphere and the pressure is taken from the piston E. The pressure on the piston G is relieved with that on the main piston by the escape of the compressed air through the main valve into the atmosphere. The gibs now lie loosely on the drill, moving with the piston on it until the edges of the holes pass the edge of the packing on the return stroke, as heretofore explained.

As the machine keeps the same position with reference to the rock, it is necessary that the drill be fed along through the piston as the hole in the rock is deepened. This is accomplished by making the distance between the outer edges, c'' c''', of the holes in the piston-rod less than the length p p''' of the packing. Now, as we have seen, the drill is released from the reciprocating parts of the machine when in the outward stroke the edges c''' of the holes c' pass the edge p''' of the packing. If, on the return-stroke, it was seized by the clutches when these edges passed each other, it would be in the same position with reference to the reciprocating parts as when it was released. It is therefore evident that the motion which the reciprocating parts take beyond this point before seizing the drill is the measure of the feed of the drill for each stroke, and is equal to the excess of the length of the packing-box over the distance between the outer edges of the holes in the piston-rod. This feed is made greater than the usual advance of the drill into the rock, and the difference is taken up by the slip of the clutches upon the drill before releasing their hold. In order that this slip may take place easily, and thereby the reciprocating parts of the machine be relieved from the shock of the blow of the drill upon the rock, the grasp of the clutches upon the drill is eased just before the drill strikes by the use of the counter-clutch piston, as above explained. This easy grasp of the clutches upon the drill could of course be secured by the use of a direct-clutch cylinder simply, (as has been employed in machines heretofore constructed,) the area of which should be equal to the difference between the areas of the direct and counter clutch pistons here used; but this easy hold is not permissible to any great extent. It is necessary that the drill should be firmly grasped for its withdrawal from the rock, for otherwise the clutches might slip upon it for a considerable and yet doubtful distance from the point at which they were set to seize it, and thus an element of uncertainty be introduced, which would be fatal to economical and efficient working. It is also necessary that the drill should be firmly held when the motion of the main piston is reversed at the end of the stroke the farther from the rock, else the momentum of the drill might cause it then to slip in the clutches, and thus another element of uncertainty be introduced. The light hold of the clutches which is needed to give the slip when the drill strikes is safe only when the drill has been withdrawn from the rock

and fairly set in motion with the piston toward it. This easy hold of the drill is better than its full release, since in the latter case it would recoil to a greater or less distance.

In its working the drill has a decided tendency to glance and change its line of direction when striking upon the face of the rock obliquely, or upon a vein of quartz, or upon any stratum of a greater or less degree of hardness than the body of the rock. In the guiding of the drill, therefore, considerable strain is likely to be thrown upon its points of support in the machine, which are, as has been explained, between the gibs and in the cross-head collar. Evidently the most strain will come upon the point of support in the cross-head, that being the nearer of the two to the rock. Now, the cross-head is guided by the slides Q″, and is altogether independent of the piston-rod with reference to transverse strain or motion, because of the peculiarity of their attachment already described. It has been customary to have the two points of support of the drill at the two ends of the piston-rod, or to have the drill slide through holes in stationary blocks. In the first case, the whole strain is thrown upon the piston-rods and their packing-boxes, causing serious wear, and thereby considerable leakage between them. In the second case, the arrangement is awkward, and the drill, if unfinished, is likely to soon wear the hole so that it shall run too loosely in it to be guided with any precision. The cross-head, being held in the slides, cannot partake of the rotary motion given to the piston-rod and drill. For this reason the joint between the rod and head is made so as to allow them to turn upon each other, and the collar is so applied to, as to be capable of turning in the cross-head. It may, however, be preferred to have the cross-head in the form of a piston running in a cylinder instead of upon slides such as represented. In that case it may rotate with the piston and drill, and the collar in the cross-head be dispensed with. If care is taken to make the cross-head slides exactly in line with the piston, it will not be necessary to provide for freedom of transverse motion between the cross-head and piston-rod, since the cross-head, even when subjected to transverse strain, will be kept by its own guides in line with the piston and no strain be thrown upon the latter.

In order to check the motion of the piston at the end of the stroke within the narrowest convenient limits, it has been not uncommon to allow the piston to pass the port by which the compressed air has been already admitted to the cylinder, and thus confine the compressed air without opportunity to escape between the piston and cylinder head. The air so confined offers a constantly-increasing resistance to the motion of the piston, thus acting to stop it sooner than if its initial pressure in the cylinder simply had been exerted. There is, however, the objection to running the piston-packing over the port—that is, it is likely to become in this way badly worn or cut—and should there be water coming over with the compressed air, (as there perhaps would be if the air was very damp before compression,) it would, when brought between the moving piston and the cylinder-head without chance of escape through the port, transmit the full blow of the piston to the cylinder-head. Now, in order to avoid the necessity of running the packing over the ports to get the cushioning required, the piston-head projects at each end the desired length beyond the packing which is on the face b^4 b^5.

The arrangement made for keeping the water from the cushioning-spaces requires for its proper action that the machine should be used with the openings r r' of the ports into the cylinder on the lowest side of the cylinder, and the end of the cylinder near the port r' not much lower than the other. The ends of the piston projecting beyond the packing are made of reduced diameter, and the bore from a a', made to fit one end and the hollow in the cylinder-head A the other, as already explained. It will be seen that if any water is thrown upon the end of the piston through the port r' it will run off into the annular space around b'' b''', which space is always open to the port, while the cushioning is upon the area b^5 b^5 of the piston. If any water comes through the port r', it will settle in the annular space between the piston-rod C and the small part of the cylinder at a a', and from it be driven back through the port when the piston strikes it. While, as has been said, this arrangement for the escape of water will not act to advantage in some positions of the machine, it yet has no disadvantages even in these positions over the ordinary plan, and the machine will be used in all positions, freeing itself in the proper way, as above explained, when it can, and choking with water like those heretofore used when it must.

It has been explained that the slide-l ar V has a reciprocating motion with the piston. As the engine makes its stroke from the end near which it is represented in the drawings, the inclined part v of the slot in the bar strikes upon the pin in the valve stem and moves it toward the valve-chest, thereby opening the main valve so as to let the compressed air into the cylinder through the port r'. On the return-stroke the incline V^2 strikes the pin, moving the valve half-way over and cutting off the compressed air, and yet not opening the exhaust. The longer edge of the pin U (see Figs. 9, 10, and 11) strikes upon the side v' of the ledge v v', by which it is kept from going too far over. When the ledge has passed from behind the pin U′, the latter is struck by the incline V^3, and the valve is moved over and opens the exhaust. The stroke of the piston is now changed, and, on returning, the ledge on the slide-bar passes just clear of the end of the pin U′, the end of the longer side of which comes opposite the narrowest part of the ledge. Although the slide bar moves the

valve, it does not always hold it after it is moved. The holding of the valve, that it may not shake out of place, is through the catching of the spring upon the pin *u*. When the valve is to be moved, the spring is lifted from the pin by the action of the yoke U′, upon which it bears, one side of which, as *u*, being raised by the pushing of the slide-bar under its beveled end. This uncatching of the spring being fairly accomplished, the incline in the bar reaches the pin U′, and through it moves the valve-stem and valve and the yoke, carrying the end of the yoke off the bar, allowing the spring to catch upon the pin in the new position of the valve.

I do not claim a cylinder, a piston, a tubular piston rod, (extending in opposite directions from the piston and entirely through both ends of the cylinder,) a set of gibs at or near each or either end of such piston-rod, and mechanism for operating such gibs, this latter mechanism being set in action by the pressure of the air in the cylinder, and its purpose being to cause the sets of gibs to alternately seize and release the drill, in order to enable it to be operated by the piston during its longitudinal movements. Nor do I claim the valve-chest, valve, and air-passages, as arranged and applied to the cylinder A, in manner substantially as hereinbefore described.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. The combination and arrangement of the piston E, the openings *c c′*, the piston-rod F, its packing *b**, the piston G, and the openings *d* with the cylinders K A, the tubular piston-rods C D, and the hollow cones I and L and the gibs J J, the whole being constructed in manner and so as to operate substantially as described.

2. The combination of the cross-head Q and the slides Q″ (constructed and operating substantially as described) with the drill N and the tubular piston C, and the combination of the collar Q′ therewith, the same being for the purpose specified.

3. The connection of the cross-head Q with the piston-rod C in such manner that there may be a freedom of transverse and rotary motion with reference to one another, as and for the purpose hereinbefore described.

4. The combination of the cushioning-space X and the piston-extension *b″ b‴*, or their equivalents, with the port *r′*, arranged in the cylinder and with reference to such space, substantially in manner as specified.

5. The construction of the cylinder A with the reduction of bore, as shown at *a a′*, and the piston B, with the part *b b′*, to operate in such reduction, the port *r* being disposed with reference thereto, as specified.

6. The combination of the spring M, the nut H, and the series of notches *h h*, or their equivalents, with the hollow cone I, the same being substantially as and for the purpose described.

7. The combination of the segments P P′ of a conical ring, the cylinders *p p′* and *p″ p‴*, the ring p^4, and the hollow cones in the head A″ and the follower A‴, the whole being substantially as and for the purposes set forth.

8. The combination of the spring W, the pin *u*, and the yoke U″ with the valve-stem U and the slide-bar V, constructed, arranged, and operating substantially as described.

9. The combination as well as the arrangement of the piston E, the piston-rod F, its packing *b**, and the piston G.

10. The combination of the openings *c c′* and *d*, the piston-rods D F, (arranged with a tubular space between them,) the pistons E and G, and the packing *b**, the whole being arranged substantially as described.

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