

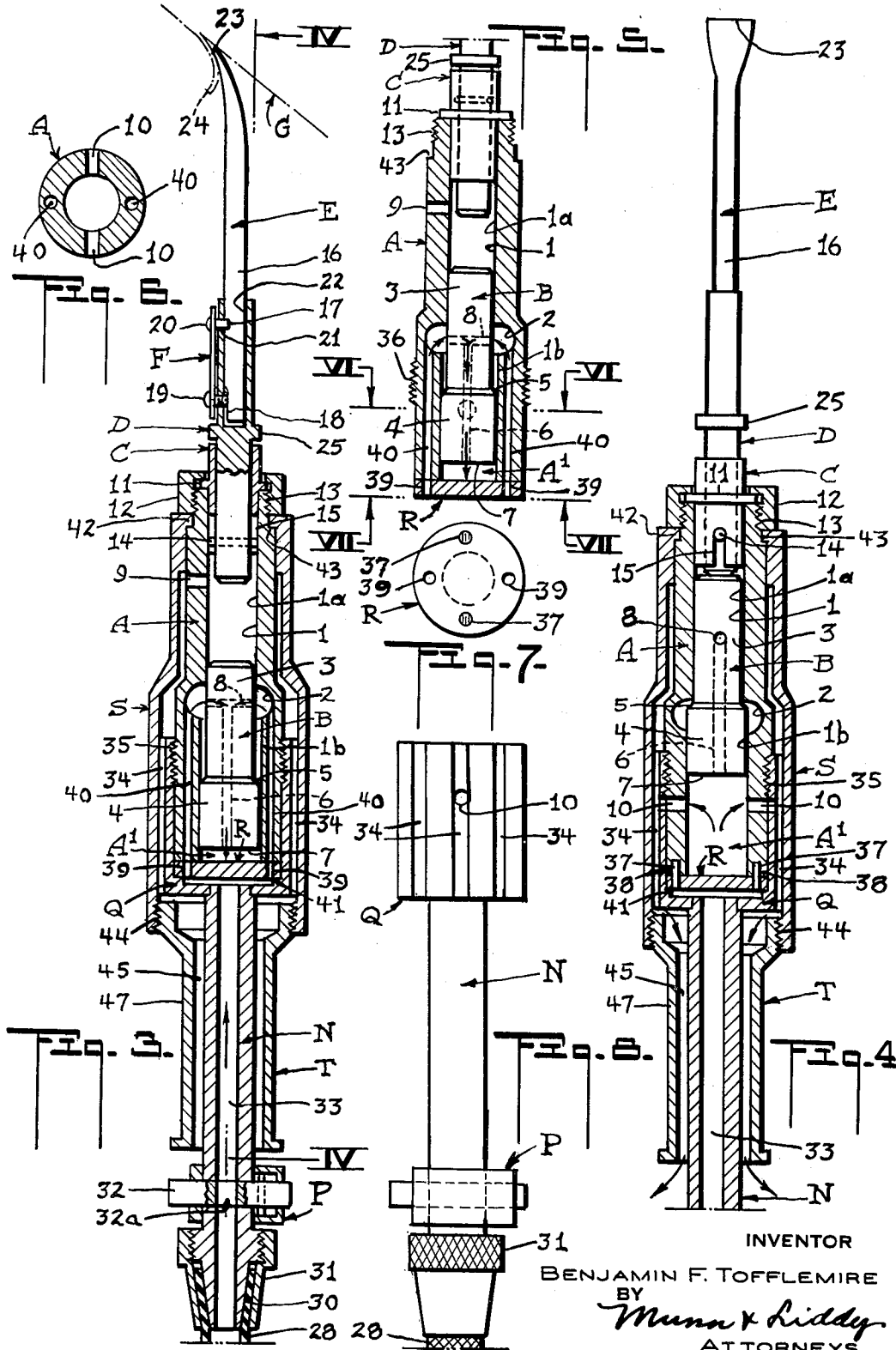
April 3, 1956

B. F. TOFFLEMIRE
PNEUMATIC CUTTING TOOL

2,740,406

Filed July 26, 1954

2 Sheets-Sheet 2



INVENTOR

BENJAMIN F. TOFFLEMIRE

BY

Munn & Liddy
ATTORNEYS

1

2,740,406

PNEUMATIC CUTTING TOOL

Benjamin F. Tofflemire, Lafayette, Calif.

Application July 26, 1954, Serial No. 445,523

5 Claims. (Cl. 128—310)

An object of my invention is to provide a pneumatic cutting tool designed to fill a long standing need for a compact, precision-controlled cutting instrument for intricate and exacting operations in the fine arts, industries, and in orthopaedic, cranial and maxillo-facial surgery. The device is so compact that it may be held in one hand with "pen-grasp" ease and this has been found so necessary in the guidance and control of delicate operations where the "tool-grasp" of more cumbersome devices would preclude their employment in exodontia and bone surgery.

The compact design of the instrument permits its use in those inaccessible and difficult-to-reach areas found in impaction-work in exodontia and bone-surgery, as well as the constricted areas in industry. Heretofore, "hammer-and-chisel" work in these constricted areas made many of these operations not only very difficult to perform, but the use of the chisel was inefficient and ineffective. The lightness of the instrument permits the surgeon to continue his intricate work without tiring or being placed under a nervous strain. Also the compactness of the instrument reduces the apprehension and nervousness of the patient in case the operation is done under a local anesthetic.

Another novel feature lies in the adaptation of carbon dioxide gas under pressure for the operation of the device instead of by compressed air or any other compressed gas. Carbon dioxide can be stored in portable containers and used for operating the tool when needed. This not only obviates the necessity of having an air-compressor available, but also eliminates the use of non-sterile, water-vapor-laden air in the operative field where the tool is being used. The elimination of the water-vapor-laden air, moreover, further protects any of the accessory equipment, such as cutters, gouges, elevators, etc., from rust and corrosion.

A novel exhaust-control mechanism of this instrument, diverts and conducts the air or gas used to operate the device, away from the operating field, thereby absolutely preventing any possible contamination of the operative field. This feature is very essential to a surgeon. The instrument is made throughout of stainless steel and so designed as to permit sterilization of the entire instrument. The corrosion resistant properties of the device assures it having a long life and freedom from rust and other corrosion-induced contaminants.

A foot-pedal control of the instrument permits the operator to concentrate on precision guidance of the instrument without the distracting loss of control and "wavering" occasioned by the grip-change necessitated by a "hand-operated" control valve.

The complete "portability" of the instrument and the compressed carbon dioxide gas, permits the surgeon to carry the equipment with him on emergency calls, or operate in the home or in smaller hospitals not equipped with safe compressor service. Likewise, the trouble-shooter in industries may carry the equipment to the scene of the trouble and permit him to reach those con-

2

stricted areas with an efficient, rapid, and fully-controlled device.

Various cutting instruments such as trimmers, gouges, chisels, rougeurs, and planes, are all readily interchangeable and are so designed as to be inserted or removed with the minimum time, effort and confusion.

Other objects and advantages will appear in the following specification, and the novel features of the device will be particularly pointed out in the appended claims.

My invention is illustrated in the accompanying drawings forming a part of this application, in which:

Figure 1 is a view of the tool shown operatively connected to a tank of compressed gas;

Figure 2 is an enlarged elevational view of the tool;

Figure 3 is an enlarged longitudinal section taken along the line III—III of Figure 1 and illustrates the pneumatically operated parts in intake position;

Figure 4 is a longitudinal section taken along the line IV—IV of Figure 3 and shows the pneumatically operated parts in exhaust position;

Figure 5 is a longitudinal section taken through the cylinder and shows the piston in elevation and in the same position as in Figure 3;

Figure 6 is a transverse section taken along the line VI—VI of Figure 5 and illustrates the exhaust ports for the cylinder;

Figure 7 is a plan view of a disc that closes the lower end of the cylinder, and the view is taken when looking in the direction of the arrows VII—VII of Figure 5; and

Figure 8 is an elevational view of the inlet tube and associate parts.

While I have shown only the preferred form of my invention, it should be understood that various changes or modifications may be made within the scope of the appended claims without departing from the spirit and scope of the invention.

In carrying out my invention I will describe the structural parts as shown in Figures 3 to 8, inclusive, and then will set forth how the tool can be connected to a tank of compressed gas, such as carbon dioxide. It is best first to refer to Figure 5 wherein I show the cylinder A as having a cylindrical bore 1 in which a piston B is reciprocally mounted. It will be noted that the upper portion 1a of the bore 1 is of a diameter slightly less than the lower portion 1b of the same bore and that the cylinder is provided with an annular groove 2 at the juncture of the cylindrical bore portions 1a and 1b. The piston has an upper reduced portion 3 which is of the same diameter as the cylindrical bore portion 1a and has a lower larger portion 4 of a diameter that is the same as the diameter of the lower cylindrical portion 1b. The piston B is free to slide within the bore 1 of the cylinder within certain limits. A shoulder 5 is formed on the piston B at the juncture of the portion 3 with the portion 4.

I provide the piston B with an axial air passage 6 that extends from the bottom 7 of the piston upwardly to a point in the reduced portion 3 where the top of the air duct communicates with a diametrically extending air passage 8, whose ends terminate at the outer surface of the cylindrical portion 3. When the piston B is in intake position, the air passage 8 will have its ends both in communication with the annular air passage 2. The cylinder A has a bleed opening 9 near its top that communicates with the upper bore portion 1a, see Figure 5; and the cylinder also has diametrically opposed exhaust ports 10, see Figure 4, that are placed in the lower bore portion 1b of the cylinder and are uncovered when the piston moves upwardly in the cylinder.

Before describing the operation of the piston, it is best first to set forth that the upper end of the cylinder receives the inner end of a guide sleeve C, see Figure 4;

3

This guide sleeve has an outwardly-extending annular flange 11 that rests against the top of the cylinder A, as clearly shown in Figure 5. A retaining flange nut 12 is threaded upon a threaded outer portion 13 of the upper end of the cylinder A and the nut acts as a fastening means for holding the guide sleeve C to the cylinder A.

Within the guide sleeve C, I reciprocally mount a plunger D, see Figure 3, and this plunger carries a pin 14 that extends transversely therethrough and has its ends slidably received in guide slots 15 that are provided in the guide sleeve C and are disposed diametrically opposite one another. The pin 14 performs the dual function of preventing rotation of the plunger D, while permitting a limited longitudinal movement thereof. The piston B on its outward movement will strike the plunger D and move it until the ends of the pin 14 reach the ends of the guide slots 15, whereupon further movement in the same direction is prevented.

A cutting implement such as a chisel E has its shank 16 provided with a notch 17 and the shank is also provided with a flattened portion 18 in line with the notch and disposed at the end of the shank. A leaf spring F is pivoted to the plunger D by means of a screw 19 and the inner end of this screw is positioned adjacent to the flattened portion 18 on the shank 16 of the chisel E to prevent rotation of the chisel with respect to the plunger. The free end of the leaf spring F carries a detent 20 and this detent is slidably received in an opening 21 provided in the plunger D and is removably received in the notch 17 of the chisel shank 16 for holding it in place. The plunger D has a socket 22 for removably receiving the chisel shank 16.

The work on which the chisel operates is indicated generally at G in Figure 3, and this may be a bone if the chisel is used for surgery purposes, or it may be a piece of wood or other material. When the pointed end 23 of the chisel is directed against the work G so as to shave off a portion as indicated at 24 in Figure 3, the forcing of the tool against the work will tend to move the plunger D inwardly in the guide sleeve C until the outward annular flange 25 on the plunger D strikes the outer end of the guide sleeve. This movement will cause the inner end of the plunger to move inwardly from the inner end of the guide sleeve so that the plunger will be in a position to be struck by the advancing piston B on its power stroke. The piston in its reciprocations will therefore drive the plunger D and the chisel E outwardly, while the force of the chisel on the work will drive the plunger inwardly as soon as the piston B has delivered its blow and starts on its return movement within the cylinder. The pin 14 holds the plunger D from flying clear of the cylinder A when the piston B strikes it.

I will now describe the means for conveying a compressed gas to the cylinder A and for conveying the spent or exhaust gas to the rear of the instrument so that this gas will not contaminate the operative area when the device is used for surgical purposes. Referring to Figure 1, it will be seen that I make use of a portable tank indicated generally at H and this tank may contain any kind of compressed gas or air desired. It is best to use carbon dioxide if the instrument is to be used for surgical purposes because this gas cannot be ignited by a spark. The tank H is provided with a main valve 26 and this controls the flow of the compressed gas to a pressure regulator indicated generally at J. A control handle 27 is mounted on the pressure regulator J and delivers the compressed gas at the proper pressure to a flexible hose 28. The control handle 27 may be adjusted so that the gas will be delivered to the instrument at a desired pressure and a pressure gauge K will indicate this pressure. A shutoff valve L is placed in the flexible line 28 and this valve is opened when the instrument is to be used. If desired, a foot-control valve indicated generally at M is placed in the flexible line 28 and this will shut off the

4

flow of gas to the instrument until a foot pedal 29 is depressed for opening the foot-control valve.

Now referring to Figure 3, it will be seen that the flexible hose 28 that carries the compressed gas has its free end attached to a conical surface 30 of an inlet tube N. A nut 31 clamps the outer end of the hose to the control end 30 and makes a gas-tight seal therewith. Figure 8 shows the inlet tube provided with a hand control cutoff valve P. Figure 3 shows the valve P provided with a plunger 32 and this plunger has a passage 32^a that is aligned with the bore 33 provided in the inlet tube N when the plunger is in the position shown in Figure 3. The plunger may be moved to close the inlet passage 33.

The inlet tube has its upper end permanently secured to a cup-shaped part Q, see Figure 8. The outer surface of this cup-shaped part Q is provided with a plurality of longitudinally extending and spaced-apart grooves 34. Figure 8 shows the exhaust ports 10 registering with certain of these grooves 34. Figure 4 illustrates how the upper end of the cup-shaped member Q is internally threaded at 35, and these threads receive the threads 36 on the outer surface of the cylinder A, see Figure 5. The exhaust ports 10 in the cup Q register with the exhaust ports 10 in the cylinder A.

The lower end of the cylinder A is closed by means of a disc R and this disc is shown in Figures 5 and 7. The disc has pins 37 that are received in recesses 38 provided in the lower end of the cylinder A. When the disc R is in place to close the lower end of the cylinder, it will be seen from Figures 5 and 7 that the inlet ports 39 in the disc will register with inlet passages 40 that extend longitudinally in the cylinder A from a lower end thereof up to the annular grooves 2 so as to communicate therewith. An annular shoulder 41 is provided within the interior and at the bottom of the cup-shaped portion Q, see Figure 4, and this shoulder spaces the disc R above the bottom of the cup so that the compressed gas can flow from the passage 33 of the inlet tube N, into the passages 40, see Figure 3, and then into the annular groove 2.

When the piston B is in its intake position as shown in Figure 3, the compressed gas will flow from the annular groove 2 and enter both ends of the transverse passage 8 in the piston B. The compressed gas will then flow downwardly through the passage 6 from the passage 8, and will enter the lower compartment A₁ of the cylinder. It will be seen that the compressed gas will force the piston B upwardly on a power stroke to strike the inner end of the plunger D and cause the chisel to cut the work G as indicated at 24 in Figure 3.

When the piston B nears the top of its power stroke, as shown in Figure 4, it will uncover the exhaust ports 10 and permit the trapped compressed gas to pass through these ports and enter the grooves 34 and flow downwardly in these grooves. An outer sheath S covers the tops of the grooves 34 so as to form them into passages. Figure 4 shows the sheath as telescoping over the cylinder A as well as over the cup-shaped member Q and as having a flange 42 at its top that is received in an annular groove 43 formed at the top of the cylinder A. The hexagonal nut 12 holds the flange 42 in the groove 43.

An outlet tubular member T, see Figures 3 and 4, has one end secured to the outer sheath S by the screw threads 44 and this tubular member is spaced from the inlet tube N so as to provide an annular exhaust passageway 45 that will lead the exhaust gases to the rear end of the instrument as shown in Figure 4, which is at a remote point from the chisel E.

From the foregoing description of the various parts of the device, the operation thereof may be readily understood.

The tool may be held in the hand in much the same manner as a fountain pen. The thumb and forefinger can grip the smooth cylindrical portion 46, see Figure 1, of the outer sheath S, and the knurled outer surface 47 of

5

the outlet tubular member T will rest on the portion of the same hand that connects the thumb with the index finger. The operator can support his hand when using the tool by resting the tops of the fingers that do not contact with the instrument, on the work being acted upon and he can guide the pointed end 23 of the chisel E against the work with a high degree of skill. Delicate control is possible when using the tool in this manner.

Both the shutoff valve L and the hand control valve P are moved into open position. The foot pedal 29 may be used for controlling the foot valve M. It is not necessary that both valves M and P be used. The compressed gas will flow through the inlet passage 33 of the inlet tube N when the valve M is opened and then will flow through the openings 39 in the disc R to enter the longitudinal passages 40 in the cylinder A. The gas will then flow into the annular groove 2 and thence into the transverse passage 8, the longitudinal passage 6, in the piston B, and will enter the lower chamber A1 of the cylinder. The piston will be moved on its power stroke by the gas trapped in the lower chamber A1 and forcing against the bottom of the piston to move it upwardly. Any trapped gas in the cylinder bore 1 which is above the piston will escape through the bleed outlet 9 and will enter the space between the sheath S and the outer surface of the cylinder A. From here the trapped gas can flow along the grooves 34 and out through the exhaust passage 45.

The upward movement of the piston B from Figure 3 to Figure 4, on its power stroke, will cause the piston to strike the plunger D and move it together with the chisel against the work G. When the piston is in its uppermost position, the inlet bore 8 in the piston, will be out of registration with the inlet groove 2 and therefore no more compressed gas can enter the bores 8 and 6. The upward movement of the piston will uncover the exhaust ports 10 and permit the compressed gas in the cylindrical compartment A1 to escape therethrough and to flow along the grooves 34, and out through the passage 45.

The piston is returned to its starting position by the compressed gas in the groove 2 bearing against the shoulder 5 on the piston, and by the fact that the piston upon striking the plunger D will rebound and start on its return movement. The compartment A1 has been relieved of its gas pressure and therefore the piston will move from the position shown in Figure 4 into that shown in Figures 3 and 5. The end of the return movement of the piston will be cushioned because the gas in the compartment A1 will be trapped as soon as the piston closes the exhaust ports 10. There will be no metallic sound from the piston as it returns in its movement and is ready to start on its next power stroke.

There will be no cushioning effect of the piston on its power stroke when striking the plunger D because any trapped gas in the upper part of the cylinder will escape through the bleed hole 9. As soon as the piston returns in its movement from the position shown in Figure 4 into that shown in Figure 3, the plunger D will also return in its movement because the chisel E is continually held against the work during the cutting operation. The pin 14 limits the outward movement of the chisel E as well as holds the chisel from rotating in the guide sleeve C.

The operator can control the instrument for delicate bone surgery and can stop and start the flow of compressed gas to the instrument by using either the foot valve M or the hand valve P.

Dry carbon dioxide is a relatively inert and a very stable compound. The gas inhibits the growth of or actually destroys bacteria. This germicidal action increases in line with the number of volumes of carbonation used. Therefore, using carbon dioxide under pressure to operate the device for surgical purposes will give an additional safety factor for the success of the operation. The inert gas will prevent any possibility of an explosion and it has fire extinguishing properties.

6

I claim:

1. A pneumatically operated tool comprising: a cylinder; a piston reciprocally mounted therein; a plunger placed at one end of the cylinder and adapted to be contacted by the piston; a guide for the plunger and secured to the cylinder; a cutting implement carried by the plunger; means for delivering gas under pressure to the cylinder for reciprocating the piston; said cylinder having exhaust ports uncovered by the piston when the latter moves in one direction; and a sheath enclosing the cylinder and having passageways communicating with the exhaust ports and extending beyond the end of the cylinder opposite to the plunger for delivering the exhaust gases at a point remote from the cutting implement.

2. A pneumatically operated tool comprising: a cylinder; a piston reciprocally mounted therein; a plunger placed at one end of the cylinder and adapted to be contacted by the piston; a guide for the plunger and secured to the cylinder; a cutting implement carried by the plunger; an inlet tube axially aligned with and operatively connected to the cylinder and adapted to deliver compressed gas to the cylinder for reciprocating the piston; said cylinder having exhaust ports uncovered by the piston when the latter moves in one direction; and a sheath enclosing the cylinder and a portion of the inlet tube and forming an exhaust passage that communicates with the exhaust ports and extends to the end of the sheath enclosing the inlet tube.

3. A pneumatically operated tool as defined in claim 2, in combination with: a flexible hose connected to the inlet tube; a portable tank containing dry, germicidal, non-explosive carbon dioxide gas under pressure; said hose communicating with the tank; and a valve arranged for controlling flow of gas from the tank to the inlet tube.

4. In a pneumatically operated tool: a cylinder; a piston reciprocally mounted in the cylinder; a plunger mounted in one end of the cylinder and adapted to be struck by the piston when the latter moves in one direction; means for limiting the outward movement of the plunger; a cutting instrument removably carried by the plunger; an inlet tube extending from the opposite end of the cylinder to that of the plunger and being axially aligned with the cylinder; means for delivering gas from the tube to the interior of the cylinder for reciprocating the piston; said cylinder having a bleed opening disposed adjacent to the plunger and having exhaust ports placed nearer the opposite end of the cylinder; and a sheath enclosing the cylinder and a portion of the inlet tube and constituting a passage for any gases escaping from the bleed opening or from the exhaust ports.

5. A pneumatically operated tool comprising a cylinder; a piston reciprocally mounted therein; an instrument-carrying plunger disposed at one end of the cylinder, the plunger being struck by the piston each time the latter is reciprocated; an inlet tube having a cup-shaped member enclosing the end of the cylinder disposed opposite to the plunger; said cylinder having intake passages placing the inlet tube in communication with the interior of the cylinder; said cylinder and cup-shaped member having exhaust ports extending there-through; the outer cylindrical surface of the cup-shaped member having longitudinally extending grooves that register with the exhaust ports; and a sheath enclosing the cylinder, the cup-shaped member and the greater portion of the inlet tube; said sheath being spaced from the inlet tube and constituting a passage for the exhaust gases from the grooves to the end of the sheath that surrounds the inlet tube; this end of the sheath opening to the atmosphere for permitting the escape of the exhaust gases at a point which is remote from the instrument carried by the plunger.

References Cited in the file of this patent

FOREIGN PATENTS

430,112 Germany ----- June 10, 1926.