

[54] PNEUMATICALLY OPERATED  
IMPACT-ACTION SELF-PROPELLED  
MECHANISM

[76] Inventors: **Boris Vasilievich Sudnishnikov**,  
Krasny Prospekt, 56, kv. 59;  
**Alexander Dmitrievich Kostylev**,  
ulitsa Derzhavina, 19, kv. 44;  
**Konstantin Stepanovich Gurkov**,  
ulitsa Derzhavina, 19, kv. 68;  
**Konstantin Konstantinovich**  
**Tupitsin**, ulitsa Krylova, 3, kv. 37;  
**Vladimir Vasilievich Klimashko**,  
ulitsa Novogodnyaya, 44, kv. 23, all  
of Novosibirsk; **Viktor Eliseevich**  
**Solomko**, ulitsa Komsomolskaya,  
105, Odessa; **Alexandr Nironovich**  
**Reinsburg**, ulitsa Mendeleeva, 5/7,  
kv. 12, Odessa; **Moisei Lvovich**  
**Yampolsky**, ulitsa Sholom  
Aleikhena, 76, kv. 31, Odessa, all of  
U.S.S.R.

[22] Filed: Feb. 23, 1972

[21] Appl. No.: 228,601

**Related U.S. Application Data**

[63] Continuation-in-part of Ser. No. 72,723, Sept. 15,  
1970, abandoned.

[52] U.S. Cl. .... 173/91, 173/137, 173/139,

175/19  
[51] Int. Cl. .... E21b 11/00  
[58] Field of Search. .... 173/135, 134, 137,  
173/139, 19, 91; 175/19

[56]

**References Cited**

**UNITED STATES PATENTS**

|           |         |                          |           |
|-----------|---------|--------------------------|-----------|
| 3,410,354 | 11/1968 | Sudnishnikov et al. .... | 173/135 X |
| 3,651,874 | 3/1972  | Sudnishnikov et al. .... | 173/135 X |
| 3,456,744 | 7/1969  | Altschuler. ....         | 173/139 X |
| 2,944,522 | 7/1960  | Doyle. ....              | 173/139 X |

*Primary Examiner*—Marvin A. Champion

*Assistant Examiner*—William F. Date, III

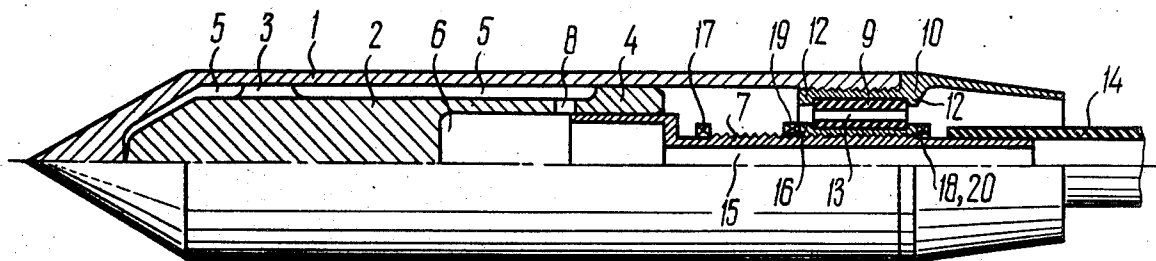
*Attorney*—John C. Holman et al.

[57]

**ABSTRACT**

A pneumatically operated impactation mechanism for forming holes in the ground or the like in which a housing has a pointed working end and receives a reciprocable impact member to successively impose impact-force on the housing through a compressed air medium; and an air supply sleeve insulated from the housing by a shock-damping bush threadingly engaged with an internal wall of the housing; and means for reversing the direction impact is imposed on the housing for facilitating removal of the housing from a formed hole or when it becomes lodged in a rock, for example.

**8 Claims, 4 Drawing Figures**



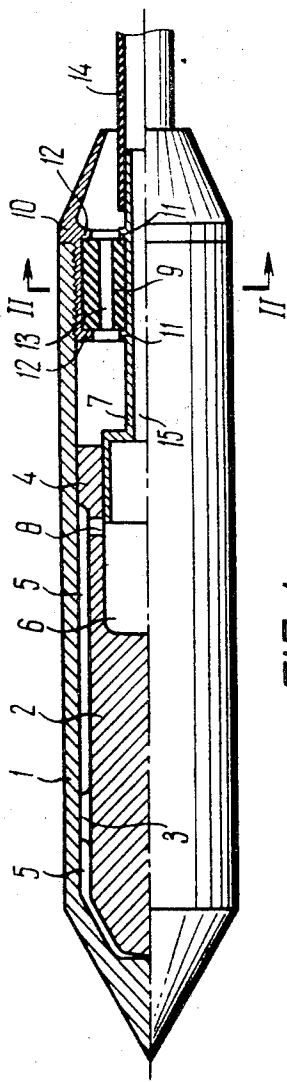


FIG. 1

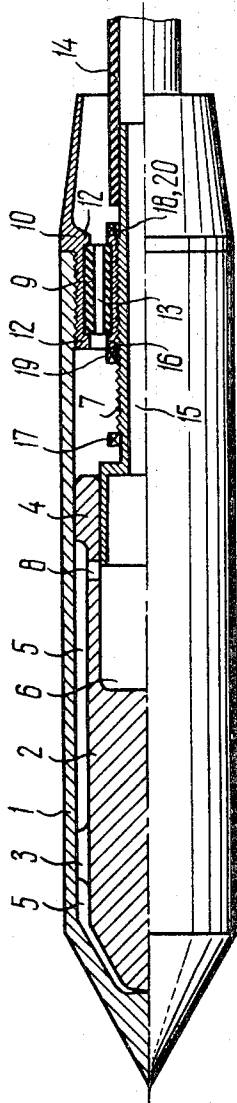


FIG. 3

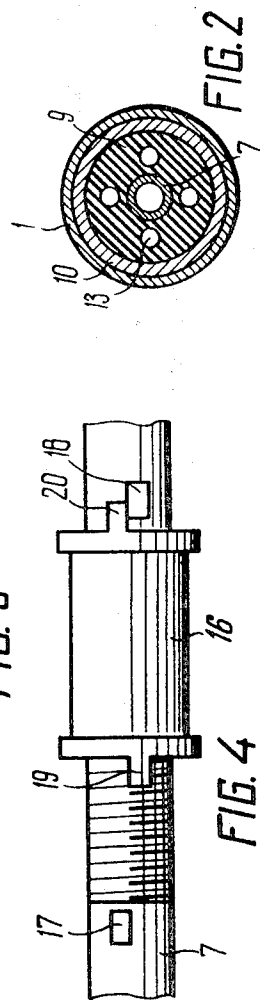


FIG. 2

FIG. 4

# **PNEUMATICALLY OPERATED IMPACT-ACTION SELF-PROPELLED MECHANISM**

This is a Continuation-in-Part of applicants' co-pending U.S. Pat. application Ser. No. 72,723, filed Sept. 15, 1970, now abandoned in favor of the present application.

The present invention relates to self-propelled impact-action pneumatically-operated mechanisms, and, more particularly, it relates to pneumatically-operated impact-action self-propelled mechanisms for making holes in the earth by compacting the soil about the hole being made.

Known from U.S. Pat. No. 3,410,354 to Svonishnikou et al. is a pneumatically-operated, impact-action, self-propelled mechanism for driving holes in the earth by compacting the soil about the hole being made, comprising a housing with a pointed (front) end portion, which accommodates an impact member reciprocating therein; delivering impacts upon the housing in the direction of its front portion and confining together therewith a front chamber of a variable volume; a sleeve mounted in the rear end portion of the housing, which by its one end portion is connected to an air pipe line and by the other end portion enters the impact member which is hermetically sealed therein, and makes it possible for the impact member to slide relative thereto to form a rear chamber of a variable volume, which is adapted to let air through into said chambers; and a shock-damping means coupled with the sleeve and designed to decrease impact loads acting on the sleeve.

The sleeve is of a stepped configuration, and with the aid of the shock-damping means fitted about the smaller-diameter portion, is suspended from a metal disc having an aperture made therethrough for exhaust of air into the atmosphere, this disc being received in a special socket in the housing and being retained in the socket by means of a nut. Thus, the shock-damping means, which is disposed between the larger diameter portion of the sleeve and the disc is subjected to compression load during successive impacts of the impact member upon the housing.

The main disadvantages of the conventional mechanism lies in that the disc and the threaded connection between the housing and the nut are subjected to rapid wear as a result of repeated impacts of the impact member. Wearing-away of the threading and breakage of the disc can be explained by the fact that the threaded connection and the disc are subjected to the pulse-type action of the inertia forces of the masses of the disc and the nut, respectively.

Early break down of the disc may be also due to the fact that the disc is weakened by the air exhaust passages. The threaded connection between the housing and the nut is also overloaded because during the impacts, this connection takes upon itself a relatively great inertia load from the disc and the nut, as well as from the sleeve as the latter is not sufficiently protected against shock loads.

Besides, when the humidity of the air is great, the air exhaust passages in the disc display a tendency toward ice formation thereon, which adversely affects the performance of the mechanism.

It is an object of the present invention to provide a pneumatically-operated impact-action mechanism in which the parts secured to the housing will not undergo relatively great impact loads.

This object is accomplished in an impact-action self-propelled, pneumatically-operated mechanism for driving holes in the earth by compacting the soil about the hole being made, comprising a housing with a pointed front end portion, which accommodates an impact member reciprocating therein, delivering impacts upon the housing in the direction of its front end portion and confining with said housing a front chamber of a variable volume; a sleeve mounted in the rear end portion of the housing, which by its one end is connected with an air pipe line and by the other end enters the impact member, is hermetically sealed therein and makes it possible for the impact member to slide relative thereto to form a rear chamber of a variable volume, and adapted to let the air pass therethrough into said chambers; a shock-damping means connected with the sleeve and designed to decrease the impact loads acting upon the sleeve, in which mechanism, according to the present invention, the shock-damping means is fashioned as a cylinder made from a resilient material, is secured inside the rear end portion of the housing and has longitudinal passages, as well as said sleeve mounted inside thereof.

As a result of the present invention there is provided a pneumatically-operated impact-action self-propelled mechanism which, while having the same power-engineering parameters, as the prior art is characterized by a longer service life.

It is expedient to secure the shock-damping means to the housing with the aid of a nut which is rigidly fastened outside the shock-damping means and is screwed into the rear end portion of the housing, which improves the technology of manufacture of the mechanism.

The present invention envisages another variant of embodiment of an impact-action, self-propelled mechanism for driving holes in the earth by compacting the soil about the hole being made, comprising a housing with a pointed (front) end portion, which accommodates an impact member reciprocating there inside, deliver impacts upon the housing in the direction of its front end and confining together therewith a front chamber of a variable volume; a sleeve mounted in the rear end portion of the housing, which by its one end is rigidly connected with an air pipe line and by the other end enters the impact member, is hermetically sealed therein to provide for their mutual sliding, is capable of rotating relative to the impact member to form together with the latter a rear chamber of a variable volume, and adapted admit compressed air into said chambers; a shock-damping means coupled with the sleeve and designed to decrease impact loads acting on the sleeve, in which mechanism, according to the present invention, the shock-damping means is fashioned as a cylinder made from a resilient material, is rigidly secured inside the rear end portion of the housing and has longitudinal passages, while said sleeve is mounted in it in a threading so that it is capable of displacing along the axis of said housing owing to selective rotation of the air pipe line, as a result of this, displacement the sleeve changes its position relative to the housing, which results in a change of the direction of the impacts delivered by the impact member, thereby changing the direction of movement of the mechanism. This makes it possible to reverse the mechanism;

It is expedient to provide the sleeve and the shock-damping means with external projections which, while

thrusting one against another, limit the selective rotation of the sleeve relative to the shock-damping means, which ensures a reliable reversing of the mechanism and precludes wedging of the screw pair.

It is also expedient to provide the shock-damping means with a casing rigidly connected thereto and having an internal thread-providing for its threaded connection with the sleeve, which makes it possible to use soft resilient materials for manufacturing the shock-damping means.

It is no less expedient to secure the shock-damping means to the housing with the aid of a nut rigidly fastened outside the shock-damping means and screwed into the rear end portion of the housing to improve the technology of manufacture of the mechanism.

The following description of an exemplary embodiment of the present invention is given with reference to the accompanying drawings, in which:

FIG. 1 shows a longitudinal section of a pneumatically operated, impact-action, self-propelled mechanism made in accordance with the present invention;

FIG. 2 is a section taken along line II—II of FIG. 1;

FIG. 3 shows a longitudinal section of another embodiment of the invention including a reversible pneumatically-operated, impact-action, self-propelled mechanism, in accordance with the present invention;

FIG. 4 is an enlarged fragmentary view of a sleeve of the mechanism with a housing screwed thereon, i.e., a reversing device.

The pointed front end portion of a hollow cylindrical housing 1 (FIGS. 1, 3) accommodates an impact member 2 resting upon the internal surface of the housing 1 at shoulders 3 and 4. The forward space defined by the housing 1 and the impact member 2 constitutes a front chamber 5 of a variable volume.

The impact member 2 has a rear space 6 telescopically receiving a sleeve 7 that is hermetically sealed therein. The space 6 of the mechanism closed by the sleeve 7 is essentially a rear chamber of a variable volume.

The wall of the impact member 2 is provided with transverse passages 8 adapted to intercommunicate the chambers 5 and 6. The sleeve 7 is pressed into a shock-damping means 9 which is pressed into a nut 10, the latter being screwed into a housing 1. The mutual axial disposition of the sleeve 7, the shock-damping means 9 and the nut 10 is fixed by flanges 11 on the sleeve 7 and flanges 12 on the nut 10 respectively.

The shock-damping means 9 is made from a resilient material and has passages 13 used for exhausting air into atmosphere.

Secured to the sleeve 7 on the end opposite to that disposed near the impact member is a hose 14 for connection to a compressed air source (not shown).

In accordance with the reversible variant of embodiment shown in FIG. 3, the mechanism is provided additionally with a casing 16 pressed into the shock-damping means 9. The sleeve 7 is mounted in the casing 16 or sleeve on threads in such a manner so that it can be displaced in the casing within the limits allowed by projections or stops 17 and 18 provided on the sleeve 7 and projections or stops 19 and 20 provided on the casing 16. The extreme front position of the sleeve 7 relative to the housing 1 is determined by the pair of projections 18 and 20 (FIG. 4), whereas its extreme rear position is determined by the pair of projections 17

and 19 which, as it has been said before respectively, contact one another in pairs.

The mechanism functions as follows.

When compressed air is supplied from a source (not shown) along the hose 14 and passage 15, disposed inside the stepped sleeve 7 into the chamber 6, the impact member 2 moves in the housing 1 in the direction of its pointed end portion and delivers an impact upon the housing 1, whereby the latter is propelled forwardly to penetrate into the soil.

When the impact member 2 moves a preset distance from the extreme front position, the passages 8 are opened to communicate the chamber 5 via the chamber 6, the passage 15 and the hose 14 with the compressed air source.

The rebound of the impact member and the force created by the air pressure in the chamber 5 initiate the impact member 2 toward performing a reverse stroke.

In the course of this reverse stroke, the passages 8 become closed by the side surface of the sleeve 7, and during the rest of the reverse stroke of the impact member 2, the compressed air in the chamber 5 is expanding. At this stage of the return stroke, the motion of the impact member 2 meets the resistance of the compressed air in the chamber 6 which is continuously connected with the source of compressed air.

At the end of the return stroke of the impact member 2, the passages 8 thereof pass beyond the head portion of the sleeve 7 to communicate the chamber 5 with the atmosphere through the passages 13 of the shock-damping means 9.

Then, the above-described operating cycle is repeated.

As the herein disclosed mechanism propels itself through the soil, every impact of the impact member 2 upon the housing 1 makes the sleeve 7 follow the motion of the housing 1, under the action of the pulse of elastic forces produced in the body of the shock-damping means 9, on account of the elastic deformation thereof, this elastic deformation of the shock-damping means 9 (which is essentially an axial shift) is due to very rapid displacement of the housing 1 relative to the stationary sleeve 7. The magnitude of this deformation depends on the initial speed of the displacement of the housing 1, on the mass of the sleeve 7 and on the characteristics of the shock-damping means 9.

As a result of the elastic properties of the shock-damping means 9, the pulse acting upon the sleeve 7 is transformed, i.e., prolonged in time and thus the peak load applied in the sleeve 7 is substantially cut down, as compared with that applied to the shock-damping means 9, and, therefore, destruction of the sleeve is prevented.

The force of recoil (i.e., the reaction force) which appears in operation of the mechanism and is directed opposite to the useful motion thereof, is counterbalanced by the friction between the housing 1 and the soil.

A series of practical tests, carried out with the mechanism built in accordance with the present invention, has shown that its service life is extended from 300 hours to 500 hours, with the weight, frequency and force of impacts being the same.

Icing of the passages 13 in the shock-damping means 9 is precluded in the following way. As a result of its deformation, the shock-damping means 9 is heated, and

its passages 13 change their shape, all this precluding formation of ice in the passages.

The operation of the reversible mechanism during its direct stroke, i.e., when a hole is being made, does not differ from the above-described operation of the mechanism shown in FIG. 1.

In case the mechanism encounters an obstacle (stones, cavities) that it cannot overcome, or the deviation of the mechanism from the preset direction of movement or drilling of a dead hole is completed, the mechanism is reversed, which is done by rotating the hose 14 which is first disconnected from the source of compressed air. The torque applied to the hose at the mouth of the hole is transmitted to the sleeve 7 which is unscrewed from the casing 16 to occupy its extreme rear position determined by its projection 17 and the projection 19 of the casing 16 after these projections have engaged each other and thrust against each other.

With the sleeve 7 occupying this position, the impact member 2 is not deliver impacts upon the forward end of housing 1, since it does prevented by the compressed air in the chamber 5 i.e., since the volume of the front chamber 5 increases (owing rearward to displacement of the sleeve 7), during its reverse stroke, the impact member 2 strikes the nut 10 and delivers impacts upon the latter, the action of the impacts delivered upon the nut 10, the mechanism is driven rearwardly and comes out of the hole.

What we claim is:

1. A pneumatically-operated impact-action self-propelled mechanism for driving holes in the earth by compacting the soil about the hole being made, comprising, in combination, a housing with a front end portion; means for supplying air; a sleeve mounted in the rear end portion of said housing for communicating with said means for supplying compressed air; an impact member for reciprocating inside said housing and delivering impacts in the direction of the front end portion of said housing in the course of a hole making, said impact member forming together with said housing a front chamber of a variable volume and together with said sleeve a rear chamber of a variable volume; said sleeve sealingly entering said impact member for relative sliding movement and functioning to pass compressed air into said chambers to effect reciprocation of said impact member; passages in said impact member for alternately communicating said front chamber with said rear chamber and atmosphere when the posi-

tion of the impact member changes relative to said sleeve; and a resilient shock-damping means inside the rear end portion of said housing and having longitudinal passages for air pass from said front chamber into the atmosphere, said sleeve being mounted inside said shock-damping means.

2. A pneumatically-operated mechanism according to claim 1, in which said shock-damping means includes a nut fixed outside thereof and screwed into the rear end portion of said housing.

3. A pneumatically-operated mechanism according to claim 1, in which said resilient shock-damping means comprises a cylinder circumposed about said sleeve.

4. A pneumatically-operated mechanism according to claim 1, including means on said sleeve for changing the mode of operation of said impact member so that the housing is driven rearwardly.

5. A pneumatically-operated mechanism according to claim 4; said sleeve being selectively rotatable in said impact member and screwed into said shock-damping means in such a manner to be displaced along the axis of said housing in such a manner that the position of the sleeve relative to said housing can be altered to change the direction of impacts delivered by said impact member for causing reversal of the mechanism operation; said impact member delivering impacts in the direction of the front end portion of said housing when said sleeve occupies a corresponding front position and delivering impacts in the direction of the rear end portion of said housing when said sleeve occupies a corresponding rear position.

6. A pneumatically-operated mechanism according to claim 5, in which said shock-damping means and sleeve include external projections which coacting to limit the selective rotation of said sleeve with respect to said shock-damping means.

7. A pneumatically-operated mechanism according to claim 5, in which said shock-damping means includes a casing connected therewith and including threads cooperating with a threaded connection on said sleeve.

8. A pneumatically-operated mechanism according to claim 5, in which said shock-damping means includes a nut secured outside thereof and screwed into a rear end portion of said housing for receiving impacts delivered by said impact member when the mechanism is driven out of a hole.

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**REEXAMINATION CERTIFICATE (1407th)**  
**United States Patent** [19] [11] **B1 3,756,328**  
**Sudnishnikov et al.** [45] **Certificate Issued Jan. 29, 1991**

- [54] **PNEUMATICALLY OPERATED  
IMPACT-ACTION SELF-PROPELLED  
MECHANISM**
- [75] **Inventors:** Boris V. Sudnishnikov; Alexander D. Kostylve; Konstantin S. Gurkov; Konstantin K. Tupitsin; Vladimir V. Klimashko, all of Novosibirsk; Viktor E. Solomko, Odessa; Alexandr N. Reinsburg, Odessa; Moisei L. Yampolsky, Odessa, all of U.S.S.R.
- [73] **Assignee:** Institut Gorgo Dela Siberskogo, Odessa, U.S.S.R.

**Reexamination Request:**  
No. 90/001,771, May 15, 1989  
No. 90/001,824, Aug. 14, 1989

**Reexamination Certificate for:**  
Patent No.: 3,756,328  
Issued: Sep. 4, 1973  
Appl. No.: 228,601  
Filed: Feb. 23, 1972

**Related U.S. Application Data**

- [63] Continuation-in-part of Ser. No. 72,723, Sep. 15, 1970, abandoned.
- [51] **Int. Cl.<sup>5</sup>** ..... **E21B 11/00**
- [52] **U.S. Cl.** ..... **173/91; 173/137; 173/139**
- [58] **Field of Search** ..... 173/139, 137, 136, 135, 173/91, 19; 175/19

[56] **References Cited**

**U.S. PATENT DOCUMENTS**

1,088,520 2/1914 Black .  
2,138,176 11/1938 Keys .  
3,407,884 10/1968 Zugmunt et al. .  
3,496,840 2/1970 Wandel .

3,651,874 3/1972 Sudnishnikov et al. .  
3,708,023 1/1973 Nazarov et al. .  
3,763,939 10/1973 Sudnishnikov et al. .

**FOREIGN PATENT DOCUMENTS**

392215 1/1966 U.S.S.R. .  
800725 9/1958 United Kingdom .

**OTHER PUBLICATIONS**

The Engineer, vol. 211, No. 5501, Jun. 30, 1961, pp. 1077-1078.  
IP-4601 Pneumatic Puncher-Certificate and Operating Instructions, Dec. 9, 1969, Odessa Printing and Offset Plant, Order No. 12724.  
IP-4601 Technical and Shipping Documents, Building and Finishing Equipment Works, USSR, Dec. 9, 1969.  
Gas World-Gas Transmission, No. 4450, Nov. 29, 1969, pp. 14-16, London.  
Design News, Rodgers Publishing Co., Chicago, Ill., vol. 24, No. 20, pp. 30-31, Sep. 29, 1969.  
Soviet Mining Science, Sudnishnikov et al., Consultants Bureau, New York, No. 2, Mar.-Apr. 1970, pp. 165-168.  
Pneumatic Reversible Piercing Machine for Driving Holes in Ground, IP-4603, Operating Instructions, Novosibirsk, 1971.

*Primary Examiner*—Frank T. Yost

[57] **ABSTRACT**

A pneumatically operated impact mechanism for forming holes in the ground or the like in which a housing has a pointed working end and receives a reciprocable impact member to successively impose impact-force on the housing through a compressed air medium; and an air supply sleeve insulated from the housing by a shock-damping bush threadingly engaged with an internal wall of the housing; and means for reversing the direction impact is imposed on the housing for facilitating removal of the housing from a formed hole or when it becomes lodged in a rock, for example.

**REEXAMINATION CERTIFICATE  
ISSUED UNDER 35 U.S.C. 307**

AS A RESULT OF REEXAMINATION, IT HAS  
BEEN DETERMINED THAT:

The patentability of claims 4, 5, 6, 7 and 8 is con-  
firmed.

Claims 1, 2, and 3 are cancelled.

THE PATENT IS HEREBY AMENDED AS  
INDICATED BELOW.

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