PATENT SPECIFICATION

DRAWINGS ATTACHED

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**1,084,496**

1,084,496

*Date of filing Complete Specification: June 10, 1966.*

*Application Date: June 15, 1965.* *No. 25186/65.*

*Complete Specification Published: Sept 20, 1967.*



Index at acceptance:—**B3** D(7, 8); **H2** A(1N, 1P)

Int. Cl.:—**B 24 c 5/08**//H 02 k

COMPLETE SPECIFICATION

# Improved Method of and Equipment for Shot-blasting and the like

We, THE BRITISH STEEL CASTINGS RESEARCH ASSOCIATION, a British Company limited by guarantee, of East Bank Road, Sheffield, 2, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to shot-blasting and like operations making use of steel or other ferrous particles as the abrading medium, hereinafter referred to simply as "shot-blasting", for such purposes as the removal of sand, scale, burrs, and flashings from metal castings, forgings, sheets, and bars, and mouldings of plastics materials; the production of peened surfaces; and the production of surfaces suitable for the anchorage of paint, enamel, or other coatings.

Whereas in the usual methods of shot-blasting and sand-blasting the particles (whether of ferrous material as "shot" or non-ferrous material, e.g., sand) are given a high velocity by means of a current of air or by flinging them from a rapidly rotating vaned impellor, the invention is based on the fact that a particle of ferromagnetic material introduced into a magnetic field tends to be drawn towards the region of highest energy density. The invention makes use of the velocity acquired by the particle in being so drawn.

According to the present invention, a method of shot-blasting comprises introducing particles of ferromagnetic material, e.g., cut wire shot, into an electromagnetically-induced travelling magnetic field, the particles being given kinetic energy by being drawn into the field, and then accelerated by acceleration of the field as a travelling wave in the required direction of travel, the energy in the wave being dissipated to allow the particles to be discharged with their acquired velocity to an article to be shot-blasted. The kinetic energy acquired enables the particles to effect shot-blasting of the article.

The continuous process of energy transfer to a group of particles may thus be carried out with a "gun" incorporating an artificial transmission line to produce travelling magnetic "pulses", which draw the particles along with them. The pulses can be supplied to the gun from a source of energy by means of a switch, such as an ignitron, thyristor, or thyratron. Thus the gun can be supplied from another artificial transmission line serving as a pulse-forming network.

For the necessary acceleration of the field, the array of capacitors and associated coils giving the travelling wave should have graded values of inductance and capacitance in each section of the array, with the ratios of inductance to capacitance of the same order at all sections. However, the ratios may be graded to compensate for the attenuation of the pulse as it travels along the system. The wave loses energy, both to the particles and also to the coils (as heat) as it travels along the system, but it still has finite energy associated with it when it reaches the end of the system, the actual amount depending on the quantity of particles flowing through the system. Dissipation of wave energy at the end of the system may be simply by allowing the wave to reflect continuously from both ends of the system; but a damping resistance may be used to overcome troublesome pulse reflections from the discharge end of the gun.

In order to counteract any components of force that tend to draw the particles away from the desired path in any of the above-described acceleration systems, the gun may contain a restraining tube, surrounded co-axially by the coils, to provide a guide path in the axial direction while the particles are in a position to be subjected to the impelling field. Thus, a tube of, or lined with, abrasion-resistant paramagnetic material may receive the continuous feed of particles and serve to direct the high-velocity particles towards the article to be shot-blasted.

The pulse-forming network shapes to substantially "square" the rear edge of the pulse fed to the gun, it being the rear edge that transfers the energy to the particles. It consists of a similar array of capacitors and coils, but has all its sections substantially identical, and has its surge impedance

$$Zo=\sqrt{\frac{L}{C}}$$

slightly greater than that of the gun. The number of sections and its $\sqrt{LC}$ value per section govern the duration of the pulse applied to the gun. The $\sqrt{LC}$ value for any section of the gun should at all stages be not less than 1/3 or 1/4 of the pulse duration.

Advantageously, the pulse repetition rate is twice the supply frequency. This enables the particles to be released into the system by a magnetic gate energised at the supply ("mains") frequency, so that each batch of particles is synchronised with the pulse, to allow them to gain some kinetic energy under the force of gravity before the pulse is applied. Each time the gate is energised at mains frequency, the field in its gap will be de-energised twice in every cycle, and each time a limited batch of particles is allowed to pass.

The invention will now be further described with reference to the accompanying drawings, in which:—

Figure 1 is a diagrammatic vertical section of a shot-blasting machine incorporating a travelling wave gun;

Figure 2 is a circuit diagram of the network of the gun and the associated pulse-forming network;

Figure 3 shows in axial section a length of a gun and two of its coils;

Figure 4 shows in axial section a length of a gun provided with concentric coils mounted for oil-cooling;

Figure 5 is a section taken on the line 5—5 of Figure 4; and

Figure 6 is a diametral section of one form of magnetic gate.

In Figure 1, a travelling wave gun 1 is directed towards a rotatable table 2 to carry articles to be shot-blasted. The table 2 is contained in a chamber 3 and is surrounded by an openwork floor 4 through which used abrasive shot and sand and/or other material removed from the articles passes to a hopper 5 and thence to the bottom of an elevator 6. After waste is removed in a separator 7, the shot is returned to a hopper 8 for re-use in the gun 1. A demagnetising coil 9 serves to remove residual magnetism, as might cause the shot to flow sluggishly. In advance of the gun 1 is a magnetic gate 10 for phasing the entry of the shot into the gun.

The gun 1 may be mounted so as to be oscillated, as indicated by the arrow 11, so as to cover as much as possible of the area of articles on the table 2, which articles may be re-positioned as necessary to enable the whole area to be shot-blasted to be reached.

For the shot-blasting of small articles, the table 2 may be replaced by tumbling equipment, e.g., an endless slatted conveyor carried by rollers or sprockets between two of which it is depressed to receive a charge of articles towards which the gun is directed, the articles being tumbled by movement of the conveyor round the rollers or sprockets.

In Figure 2, the gun 1 (operating to discharge shot in the direction of the arrow 12) has an intense travelling magnetic field produced by an artificial transmission-line network of capacitors 13 and associated coils 14, the coils having a large ratio of inductance to axial length, and the ratios of inductance $L_1$, $L_2$, etc., to capacitance $C_1$, $C_2$, etc. being of the same order throughout, but graded to compensate for attenuation of the electrical pulse as it travels along the network. High-value capacitors are used to produce "wave-velocities" sufficient for shot-blasting. The gun network receives the pulse from a similar network 15 of capacitors 16 and coils 17 fed from a D.C. supply through a charging rectifier 18 and a charging inductance 19. The pulse-forming network may be located at any suitable position in the shot-blasting equipment, and connected to the gun network through a switch 20, such as an ignitron, thyristor, or thyratron. A damping resistor 29 is connected across the discharge end of the gun network.

The coils 14 of the gun network are co-axial with the gun. Thus, each section of the gun may consist of two coils 14 (Figure 3) mounted on a guide tube 21 for the shot and separated from each other by a ferrite washer 22 or by magnetic laminations, disposed between insulating washers 23. However, cooling of the gun is desirable, and this may be provided by the use of concentric coils, 14A as shown in Figures 4 and 5. Insulated spacers 24 provide concentric spaces between the coils and insulating washers 23A with radiating arms next to the ends of the coils provide for circulation of oil to and along the coils from a surrounding tube 25 of insulating material along which oil flows to and from an external heat-exchanger (not shown). The coils etc. are separated from the guide tube 21 (of abrasion-resistant material) by an insulating tube 26, which may also be provided in the coil arrangement of Figure 2.

The magnetic gate 10 of Figure 6 is mounted co-axially on the guide tube 21 (see Figure 1) and consists of a concentric coil 27 synchronised with the pulse fed to the gun, and radial magnetic laminations 28. An alternative form of magnetic gate consists of a C-shaped assembly of magnetic laminations, with a gap through which the guide tube 21 passes, and a coil surrounding the back of the assembly.

WHAT WE CLAIM IS:—

1. A method of shot-blasting, comprising introducing particles of ferromagnetic material, e.g., cut wire shot, into an electromagnetically-induced travelling magnetic field, the particles being given kinetic energy by being drawn into the field, and then accelerated by acceleration of the field as a travelling wave in the required direction of travel, the energy in the wave being dissipated to allow the particles to be discharged with their acquired velocity to an article to be shot-blasted.

2. A method as in Claim 1, comprising the use of an artificial transmission line to produce travelling magnetic "pulses", which draw the particles along with them.

3. A method as in Claim 2, wherein the pulses are supplied from another artificial transmission line serving as a pulse-forming network.

4. A method as in any of Claims 1 to 3, wherein the wave energy at the end of the system is dissipated by allowing the wave to reflect continuously from both ends of the system.

5. A method as in any of Claims 1 to 3, wherein the wave energy at the end of the system is dissipated by a damping resistance.

6. A method as in any of Claims 1 to 5, wherein the particles are released into the system by a magnetic gate.

7. A method of shot-blasting by the use of a travelling magnetic field substantially as hereinbefore described.

8. Shot-blasting equipment using a travelling magnetic field substantially as hereinbefore described with reference to the accompanying drawings.

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269 Glossop Road,
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Leamington Spa: Printed for Her Majesty's Stationery Office by the Courier Press.—1967.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.

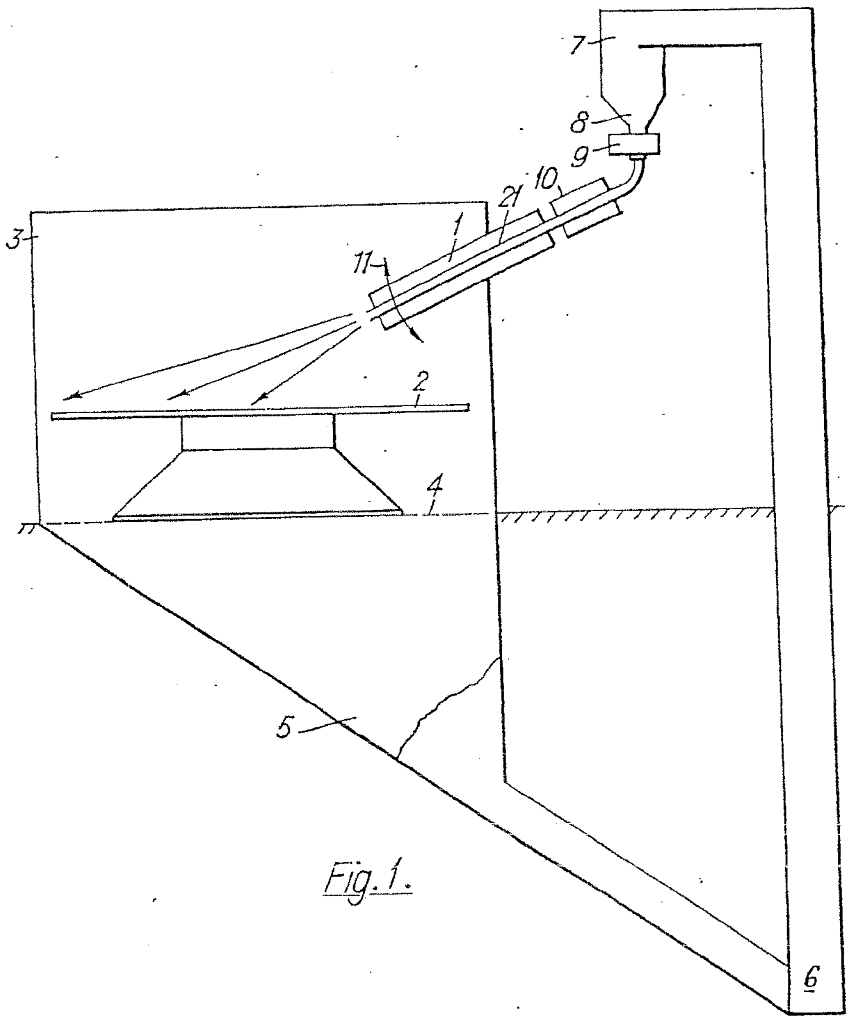
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Fig. 1.

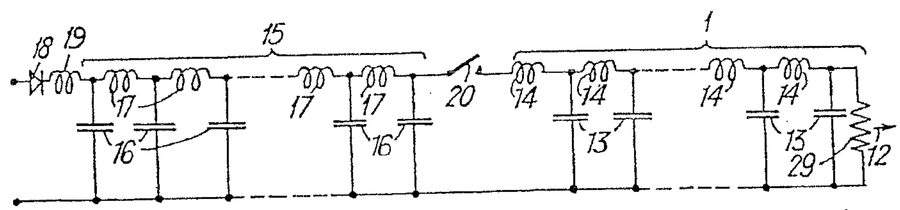
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Fig. 2.

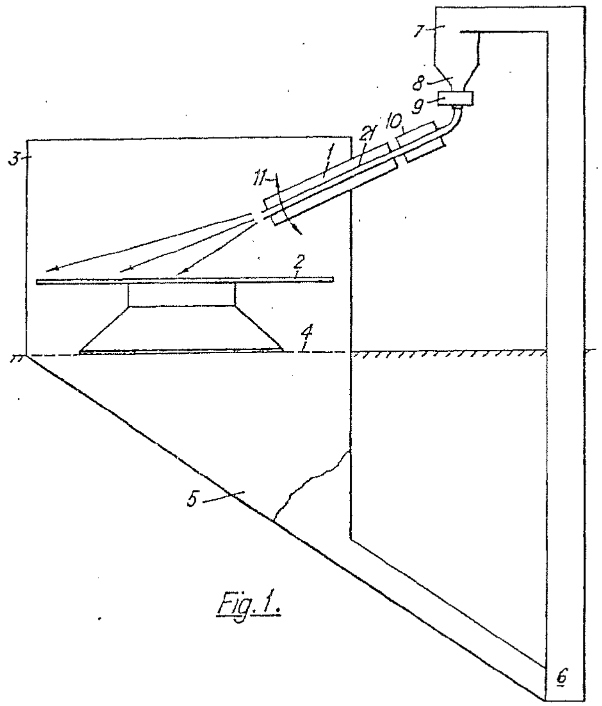

Fig.1.

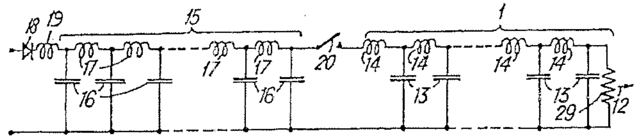

Fig.2.

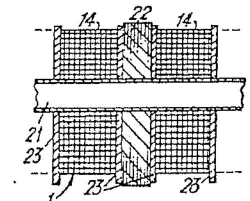

Fig.3.

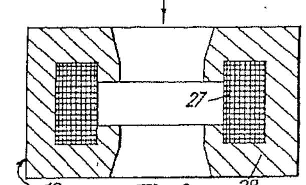

Fig.6.

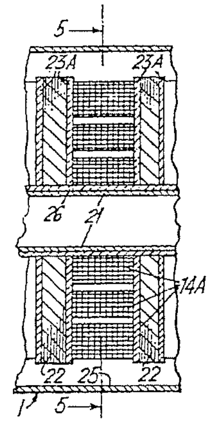

Fig.4.

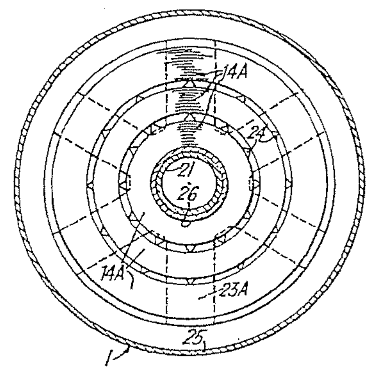

Fig.5.

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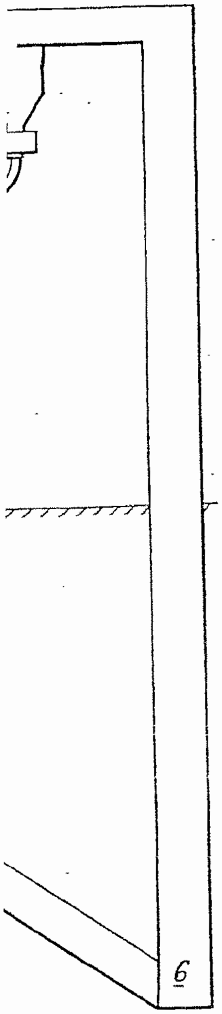
2 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheets 1 & 2



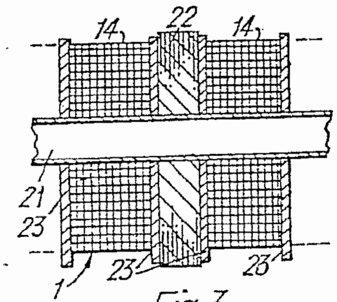




Fig.3.

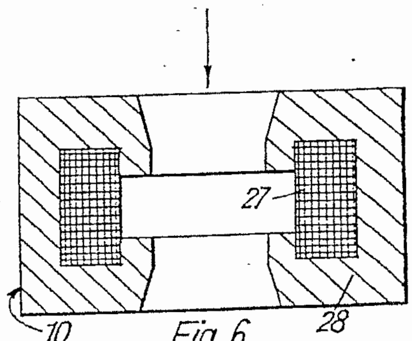



Fig.6.

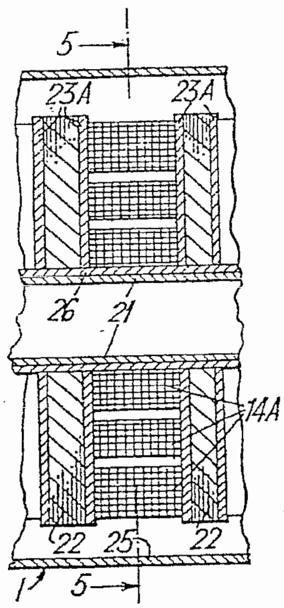



Fig.4.

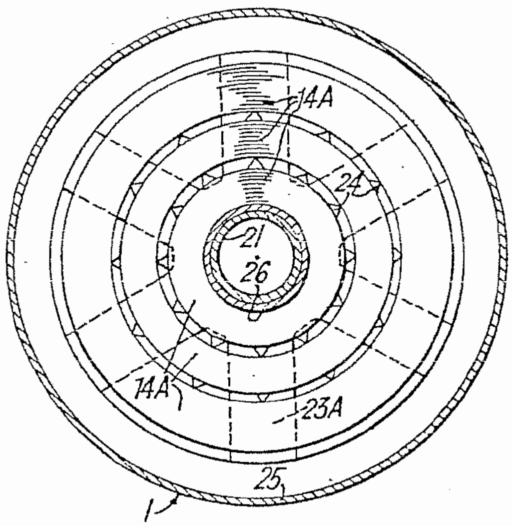



Fig.5.