

# PATENT SPECIFICATION

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(19)



## (54) PORTABLE DEVICE FOR TREATING SURFACES

(71) We, WHEELABRATOR-FRYE INC., a corporation of the State of Delaware, of Liberty Lane, Hampton, New Hampshire, United States of America, 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:—

10 This invention relates to a device for treatment of surfaces with particulate material thrown at high velocity onto the surface and it relates more particularly to a portable device which makes use of one or more wheels having radially extending blades for throwing, by centrifugal force, particulate material such as steel shot, grit, or abrasive particles against the surface for cleaning, abrading, or other surface treatment.

20 Recovery for re-use of abrasive or other particulate material is essential to the successful operation of the device, otherwise the cost of particulate material or abrasive becomes excessive, the means for supplying of the large volumes of abrasive material imposes a similar problem of size and weight, and the means for disposal of spent abrasive material increases the problem of size and weight.

30 Recovery of particulate material and abrasive entails the problems of removal of the particulate material and abrasive from the surface after they have served their purpose, separating re-usable particulate material and abrasive from the dust, dirt and fines picked up from the surface, and returning the cleaned particulate material or abrasive for recycle to the centrifugal blasting wheel for re-use in surface treatment.

40 Such recovery, cleaning and recycle of cleaned particulate material and abrasive must be embodied in a unit with the centrifugal wheels and housings for confinement

ment of the abrasive particles thrown from the wheels if the unit is intended for use as a portable surface cleaning or treating device.

Present surface treatment devices of the 50 type described, especially for the treatment of horizontal surfaces, such as floors, ships' decks, roads, runways and the like, are very large and difficult to maneuver in relatively small areas. A great deal of the length and weight is taken up by the recovery, cleaning and recycle system for the used particulate material or abrasive.

Embodiments of this invention seek to provide a portable surface treating device 60 of the type described which is of a size and weight to be easily maneuverable over the surface to be cleaned or otherwise treated, in which means are provided for recovery of the re-usable abrasive or other particulate material, in which the recovered abrasive or particulate material is cleaned and recycled as feed to the centrifugal throwing wheel in a simple and efficient manner which requires a minimum of space and 70 additional equipment, and in which the abrasive or other particulate material is substantially completely removed from the cleaned or treated surfaces thereby to minimize the loss of material, and the 75 amount of additional cleaning required to remove the dust and residue from the cleaned or treated surfaces.

According to the invention there is provided a portable apparatus for treatment 80 of surfaces comprising a movable housing having an opening therein for facing the surface to be treated; means within the housing for projecting abrasive particles through a blast corridor into engagement 85 with the surface from which the abrasive particles rebound from said surface for travel through a rebound corridor, said blast corridor and rebound corridor making opposite acute angles with said surface, 90

said rebound corridor providing a substantially continuous unobstructed passage away from said surface for rebound of spent abrasive particles through said corridor to a level above said projecting means for return of abrasive particles to said projecting means, wherein the rebound corridor extends continuously curvilinearly upwardly from said opening to an outlet located at a level above the projecting means such that the abrasive particles fall gravitationally from the end of the corridor to a hopper.

Embodiments of the invention will now be described by way of example with reference to the accompanying drawings in which:—

Fig. 1 is a schematic sectional elevational view showing the essential elements of a portable apparatus embodying the features of this invention for cleaning a floor, ship's deck or other horizontally disposed surface;

Figure 2 is an elevational plan view of a modified apparatus of the type shown in Fig. 1; and

Fig. 3 is an elevational view from the front and side of a preferred configuration for the rebound corridor.

The invention will be described with reference to an apparatus for cleaning a horizontally disposed, relatively flat surface, such as a floor 18, ship's deck, airport runway, street and the like, but it will be understood that the apparatus to be described has application also for the treatment of surfaces other than flat and other horizontal, such for example as a roller surface, inclined surface and even a vertical surface.

While the invention will hereinafter be described with reference to the use of hard abrasive particles for cleaning such surfaces, it will be understood that the apparatus of this invention has application for the treatment of surfaces with other particulate material for use in cleaning surfaces, removal of surface finishes, hardening surfaces as by peening or impacting, and for providing certain finishes to a metal, plastic, wooden and the like surface. The type of surface treatment or finish depends on the material projected onto the surface such as for surface cleaning or softer materials steel shot, steel grit, metal abrasive, sand such as particulate organic materials in the form of nut shells, nut seeds, wooden or plastics particles and the like for surface finishing, hereinafter collectively referred to as abrasive particles.

Referring now to the drawings, illustration is made of an apparatus 10 which includes a rigid frame 12 mounted on wheels 14, one of which is in the form of a caster

wheel 16 for enabling movement of the apparatus in various directions over the surface 18 to be treated. The apparatus may be adapted for movement by hand, in which event handle bars 20 are provided to extend rearwardly from the frame, or the apparatus may be powered for movement over the surface, as by means of a hydraulic motor drive 21, in which event a platform 22 is provided to extend rearwardly from the frame and on which the operator 24 rides, with steering means 26 for maneuvering the apparatus over the surface to be treated.

The apparatus 10 is provided with one or more centrifugal wheels 30 enclosed within a protective housing 32. The wheel 30 is generally referred to as a centrifugal blasting wheel, of the type well known to the trade, and marketed by Wheelabrator-Frye Inc., of Mishawaka, Indiana, under the name WHEELBRATOR (Registered Trade Mark). The wheel is rotated at high speed on an axle 34 driven by an electrical motor 36. Instead of a direct motor drive, rotational movement at high speed can be imparted to the wheel by means of a belt drive which interconnects a pulley on the end of the axle with a motor driven sheave offset from the wheel axis.

Abrasive particles are fed from a supply hopper 38 through a feed spout 40 to a cage in the center of the wheel. The cage dispenses the abrasive particles onto the inner end portion of the blades 42 which extend radially outwardly in circumferentially spaced relation from the hub, whereby, in response to rotational movement of the wheel, the abrasive particles 39 are displaced radially outwardly over the surfaces of the blades and thrown with high centrifugal force from the ends of the blades in a direction controlled by the cage. The rate of flow of particulate material is controlled by a control valve in the feed system.

As illustrated in Fig. 1, the wheel axle is inclined so that the abrasive particles will be thrown from the blades angularly downwardly through a similarly inclined blast corridor 44 onto the surface 18. The cleaning efficiency and rebound of the abrasive particles, for best recovery, is somewhat dependent upon the angle of inclination at which the abrasive particles strike the surface which angle corresponds to 90° minus the angle of inclination that the wheel axle makes with the horizontal. The angle of inclination that the wheel axle makes with the horizontal should be less than 60° and not less than 10° so that the angle at which the abrasive particles strike the surface will not be less than 30° nor greater than 80° and preferably within the range of 45° to 65°.

When the abrasive particles are thrown

at high velocity angularly onto the surface, they tend to rebound from the surface at a reflective angle. For recovery of the spent abrasive particles, there is provided a rebound corridor 46 which extends upwardly from the surface, initially at an angle corresponding to the reflective angle to 10° to 15° less than the reflective angle. The angular relationship of the rebound corridor increases through the upper portions thereof for guiding the rebounding abrasive particles upwardly preferably to a level above the hopper 38 and preferably through a backward angle of more than 180° with the surface for continued movement of the rebounding abrasive particles in response to gravitational force after the particles pass the zenith of the rebound corridor 46.

Thus the blast corridor 44 and the rebound corridor 46 merge at their lower end portions to provide a downwardly facing opening 48 therebetween, which defines the blast area through which the abrasive particles are thrown onto the surface and from which they rebound for return through the rebound corridor 46.

The blast corridor is defined by front and back walls 50 and 52 and side walls 54 while the rebound corridor is defined by front and back walls 56 and 58 and side walls 60. The lower edges of the walls 52, 58, 54 and 60, which define the opening 48, terminate a short distance above the surface 18. The area is enclosed by a resilient skirt 62 which depends from a bracket 64 fixed to the lower edge portions of the surrounding walls. The skirt 62 is intended to enclose the area to confine the blast and to prevent ricocheting of abrasive particles to the region outside of the housing. The skirt is characterized by sufficient flexibility to permit abrasive particles, collected on a surface 18, to pass beneath the skirt and to permit air to be drawn about the underside of the skirt from the outside atmosphere into the blast area, as will hereinafter be described. For this purpose, the skirt is formed of a rubber-like material dimensioned preferably to engage the surface or to terminate a short distance above the surface.

Advantage is taken of the kinetic energy imparted to the abrasive particles striking the surface whereby the abrasive particles rebound from the surface into the upwardly inclined rebound corridor at an angle which is somewhat less than the reflective angle at which the abrasive particles strike the surface. Thus the kinetic energy of the particles is used to collect the spent abrasive particles and to carry them through an air wash cycle and return to the feed hopper for re-use.

This eliminates the need for collectors and conveyors otherwise required to recover the abrasive particles and to recycle the re-usable abrasive to the blast wheel. It also eliminates the need to incorporate means for otherwise dissipating the kinetic energy imparted to the abrasive particles by the wheel and it minimizes the excessive wear of surfaces by abrasive whereby frequent repair or replacement is required.

In the modification shown in Fig. 1, the air wash housing 70 immediately underlies the end of the rebound chamber. The air wash housing 70 contains a series of vertically staggered shelves, such as shelves 72, 74, 76, extending inwardly from opposite side walls 78 with the inner of the shelves overlapping so that as the particulate material builds up on an upper shelf, the material overflows the upper shelf onto a lower shelf in a manner to distribute the particulate material so that it will fall as a uniform curtain from the lowermost shelf 76. Air at controlled velocity is circulated through the curtain from an inlet 74' at one side to an outlet 76' at the other. The air with entrained dust and fines is conveyed from the outlet 76' to the blower (not shown).

In the modification shown in Fig. 2, use is made of a centrifugal fan 66 having an inlet at the central axis which communicates through duct 68 with an outlet 76' to an expansion chamber. Duct 78 communicates the outlet 80 from a peripheral portion of the centrifugal fan with an inlet 74' on the other side of the air wash housing 70.

In operation, abrasive particles, such as steel shot, rebound from the surface 18 through the scroll 60 into the air wash housing 70. Air introduced through the inlet 74' crosses the curtain of abrasive particles and dusts falling from the abrasive particles. The abrasive particles fall gravitationally into the hopper 38 while the air, with entrained dusts and fines, is removed via the duct 90 for transfer to a dust collector. Particulate residue that remains on the surface 18 passes under the skirt 62 and is picked up by a vacuum cleaner nozzle 88 for transfer through duct 86 to an expansion chamber 92. In the expansion chamber, the abrasive particles fall gravitationally into the supply hopper 38, while the dusts and fines flow with the air through outlet 76' into duct 68, to the inlet to the fan 66 and provide the air stream which is circulated through the duct 76 to the inlet 74'. As described, the dirty air from the air wash goes to the dust collector.

The relatively small amount of abrasive particles which do not traverse the rebound corridor, fall back onto the surface and pass under the skirt 62 about the blast area.

These particles are picked up by the trailing auxiliary pickup unit, illustrated in Fig. 2 as a vacuum cleaner, but which may otherwise be in the form of a magnetic drum, rotating brush or the like. It will be understood that the power requirement for operating such auxiliary unit to pick up the small amount of abrasive particles remaining on the surface 10 is materially less than the power that would otherwise be required fully to recover the abrasive particles within the blast unit itself.

Since the great majority of the abrasive particles, entrained dust and fines, rebound with sufficient kinetic energy to pass through the rebound corridor for cleaning and for return of the re-usable abrasive particles to the supply hopper, it is possible markedly to increase the recovery capabilities of the device without placing great reliance on auxiliary recovery systems which can therefore be made to operate simply and efficiently, and without the need to utilize much space or energy for substantially complete recovery of the abrasive particles.

When adapted to operate on horizontally disposed surfaces, it is preferred that the rebound corridor extend curvilinearly upwardly through an angle of at least 180° and preferably through an angle of 190-210° to the horizontal so that it will terminate in an end portion which extends angularly downwardly, preferably in the direction of the hopper 38, as illustrated in Fig. 3, whereby the particulate material travels over a hump 57 at the top during passage through the rebound corridor.

An important concept of the embodiments described resides in the configuration and size of the rebound corridor 46 whereby utilization is made of air flow to assist the kinetic energy in carrying the abrasive particles through the rebound corridor so that substantially all of the abrasive particles, dust and fines traverse the rebound corridor to at least the end, at which point gravitational forces become effective to carry the abrasive particles through the air wash 70 and return to the supply chamber 38.

For this purpose, the walls of the curvilinear rebound corridor converge gradually substantially uniformly from the end whereby the cross-section of the corridor decreases gradually from the inlet substantially throughout the length of the reduced corridor. Such gradual diminishing cross-section has the effect of increasing the rate of flow of air through the corridor by an amount which corresponds substantially inversely to the square of the cross-section of the corridor. Thus the linear velocity of the air stream increases rapidly as it flows upwardly through the rebound corridor

whereby the increased velocity in the upper end portion of the corridor is sufficient, in addition to the kinetic energy, to carry the particulate materials for complete traverse of the rebound corridor.

While the decrease in cross-section may continue to the end of the corridor, it is not necessary to effect such decrease beyond the hump in the corridor since gravitational force thereafter becomes effective to assist in the continued flow of the particulate material to the end of the corridor for passage through the air wash and return of the cleaned abrasive particles to the hopper.

For purposes of illustration, but not by way of limitation, the curvature and dimensional characteristics of a rebound corridor representative of commercial practice are given in Fig. 3 in which the rebound corridor is shown as decreasing at a rate more rapid than the outer wall 58. It will be understood that the size of the rebound corridor can vary, depending somewhat upon the capacity of the apparatus.

A further important concept of the embodiments described resides in the means for inducing large volumes of air to enter into the blast area, especially into the zones immediately surrounding the blast area for entrainment of fines, dust, dirt and abrasive particles within the blast area. The air flow serves to induce the entrainment of residual abrasive particles, dust and dirt which fall back onto the surface and to supplement the kinetic energy of the rebounding particles for travel through the rebound corridor.

The flow of air into the blast chamber is induced, in part, by the fan of the dust collector and by the rotation of the blast wheel as well as the abrasive particles travelling at high velocity through the blast chamber whereby subatmospheric conditions exist within the blast chamber. This causes air to be drawn into the blast chamber from the outside atmosphere about the underside of the skirt. This operates to sweep residual particles from the surface into the main stream and to induce the particles to rise into the main stream and join the line of travel of the rebounding particles into and through the rebound corridor.

In addition to the air flow maintained by the blower 66, the velocity at which the particles travel into and out of the blast area is effective to increase the force of the air stream further to induce the desired sweeping action and entrainment of particles for their re-entry into the line of flow of the rebounding particles for travel through the rebound corridor.

Thus the kinetic energy of the particles plus the induced air flow is employed to collect the spent abrasive particles and to

5 carry them with the dust, dirt and other  
fines from the surface, through the re-  
bound chamber, to a cleaning cycle, such  
as an air wash and return to the feed hop-  
per for re-use.

10 This eliminates the need for collectors  
and conveyors otherwise required to re-  
cover the abrasive particles and to recycle  
the re-usable abrasive to the blast wheel.  
15 It also eliminates the need to incorporate  
means for otherwise dissipating the kinetic  
energy imparted to the abrasive particles  
by the wheel and it minimizes the exces-  
sive wear of surfaces by abrasive whereby  
frequent repair or replacement is required.

20 The cleaning effect is derived, at least in  
part, by the beat of the abrasive particles  
thrown sequentially by the radially spaced  
blades of the wheel, while the latter is  
rotating at high speed.

25 Instead of making use of gravity feed  
from the hopper to the wheel, use can be  
made of other systems for feeding particu-  
late material to the wheel such as a pneu-  
matic feed, screw feed, or other means for  
positive displacement of abrasive particles  
in the desired amounts. Under such cir-  
cumstances it is not essential to have the  
rebound corridor rise to a certain level, al-  
though it is preferred that the rebound  
corridor terminate at a downward incline  
so as to be able to take advantage of  
gravitational forces for continued process-  
ing of the recovered particles.

35 Instead of handle bars 20 or platform  
22 being mounted on the rear of the ap-  
paratus, it will be understood that such  
control means can be provided on the opposite  
end or both ends of the apparatus for en-  
abling movement in either direction.

40 From the foregoing, it will be apparent  
that an apparatus is provided for the treat-  
ment of surfaces in which utilization is  
made of kinetic energy resident in the  
abrasive particles to enable recovery of the  
abrasive particles in an efficient and eco-  
nomical manner whereby size, weight and  
cost of the unit can be greatly reduced,  
while providing greater maneuverability,  
50 by hand or by power operated means, over  
the surface to be treated.

Reference is invited to our co-pending  
Application No. 42684/78 (Serial No.  
1 585 478), which describes and claims a  
portable apparatus for treatment of substan-  
tially horizontally disposed surfaces com-  
prising a movable housing having an open-  
ing therein for facing the surface to be  
treated, means within the housing for pro-  
jecting abrasive particles downwardly  
60 through a blast corridor into engagement  
with the surface from which the abrasive  
particles rebound upwardly from said sur-  
face for travel through a rebound corridor  
65 making opposite acute angles with said sur-

face, said rebound corridor providing a  
substantially unobstructed passage away  
from said surface for rebound of spent  
abrasive particles through said corridor for  
return of abrasive particles to said project-  
ing means, and means communicating with  
the rebound corridor for inducing the flow  
of air from the outside atmosphere into the  
blast opening and through the rebound cor-  
ridor for inducing the removal of abrasive  
and other particles from the treated surface  
while aiding rebounding of the particles  
through the rebound corridor, wherein the  
rebound corridor extends continuously cur-  
vilinearly upwardly from said opening to an  
outlet located at a level above the projecting  
means such that the abrasive particles fall  
gravitationally from the end of the corridor  
to a hopper.

#### WHAT WE CLAIM IS:—

1. A portable apparatus for treatment of  
surfaces comprising a movable housing hav-  
ing an opening therein for facing the surface  
to be treated, means within the housing for  
projecting abrasive particles through a blast  
corridor into engagement with the surface  
from which the abrasive particles rebound  
from said surface for travel through a re-  
bound corridor, said blast corridor and re-  
bound corridor making opposite acute  
angles with said surface, said rebound cor-  
ridor providing a substantially continuous  
unobstructed passage away from said sur-  
face for rebound of spent abrasive particles  
through said corridor to a level above said  
projecting means for return of abrasive par-  
ticles to said projecting means, wherein the  
rebound corridor extends continuously cur-  
vilinearly upwardly from said opening to an  
outlet located at a level above the projecting  
means such that the abrasive particles fall  
gravitationally from the end of the corridor  
to a hopper.

2. An apparatus as claimed in Claim 1,  
in which, when the surface to be treated  
comprises a horizontally disposed surface,  
the rebound corridor extends angularly up-  
wardly to a level above the hopper for  
return of abrasive particles by gravity  
from the rebound corridor to the hopper.

3. An apparatus as claimed in Claim 2,  
which includes an air wash between the ends  
of the rebound corridor and the hopper for  
removal of fines and dust from the abrasive  
particles before return to the hopper.

4. An apparatus as claimed in any pre-  
ceding Claim, in which the blast opening is  
located in the bottom side of the housing.

5. An apparatus as claimed in any pre-  
ceding Claim, in which the blast corridor  
extends at an angle within the range of 30-  
80° to the surface.

6. An apparatus as claimed in Claim 5,  
in which the rebound corridor extends at an



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carry them with the dust, dirt and other fines from the surface, through the rebound chamber, to a cleaning cycle, such as an air wash and return to the feed hopper for re-use.

This eliminates the need for collectors and conveyors otherwise required to recover the abrasive particles and to recycle the re-usable abrasive to the blast wheel. It also eliminates the need to incorporate means for otherwise dissipating the kinetic energy imparted to the abrasive particles by the wheel and it minimizes the excessive wear of surfaces by abrasive whereby frequent repair or replacement is required.

The cleaning effect is derived, at least in part, by the beat of the abrasive particles thrown sequentially by the radially spaced blades of the wheel, while the latter is rotating at high speed.

Instead of making use of gravity feed from the hopper to the wheel, use can be made of other systems for feeding particulate material to the wheel such as a pneumatic feed, screw feed, or other means for positive displacement of abrasive particles in the desired amounts. Under such circumstances it is not essential to have the rebound corridor rise to a certain level, although it is preferred that the rebound corridor terminate at a downward incline so as to be able to take advantage of gravitational forces for continued processing of the recovered particles.

Instead of handle bars 20 or platform 22 being mounted on the rear of the apparatus, it will be understood that such control means can be provided on the opposite end or both ends of the apparatus for enabling movement in either direction.

From the foregoing, it will be apparent that an apparatus is provided for the treatment of surfaces in which utilization is made of kinetic energy resident in the abrasive particles to enable recovery of the abrasive particles in an efficient and economical manner whereby size, weight and cost of the unit can be greatly reduced, while providing greater maneuverability, by hand or by power operated means, over the surface to be treated.

Reference is invited to our co-pending Application No. 42684/78 (Serial No. 1 585 478), which describes and claims a portable apparatus for treatment of substantially horizontally disposed surfaces comprising a movable housing having an opening therein for facing the surface to be treated, means within the housing for projecting abrasive particles downwardly through a blast corridor into engagement with the surface from which the abrasive particles rebound upwardly from said surface for travel through a rebound corridor

face, said rebound corridor providing a substantially unobstructed passage away from said surface for rebound of spent abrasive particles through said corridor for return of abrasive particles to said projecting means, and means communicating with the rebound corridor for inducing the flow of air from the outside atmosphere into the blast opening and through the rebound corridor for inducing the removal of abrasive and other particles from the treated surface while aiding rebounding of the particles through the rebound corridor, wherein the rebound corridor extends continuously curvilinearly upwardly from said opening to an outlet located at a level above the projecting means such that the abrasive particles fall gravitationally from the end of the corridor to a hopper.

#### WHAT WE CLAIM IS:—

1. A portable apparatus for treatment of surfaces comprising a movable housing having an opening therein for facing the surface to be treated, means within the housing for projecting abrasive particles through a blast corridor into engagement with the surface from which the abrasive particles rebound from said surface for travel through a rebound corridor, said blast corridor and rebound corridor making opposite acute angles with said surface, said rebound corridor providing a substantially continuous unobstructed passage away from said surface for rebound of spent abrasive particles through said corridor to a level above said projecting means for return of abrasive particles to said projecting means, wherein the rebound corridor extends continuously curvilinearly upwardly from said opening to an outlet located at a level above the projecting means such that the abrasive particles fall gravitationally from the end of the corridor to a hopper.

2. An apparatus as claimed in Claim 1, in which, when the surface to be treated comprises a horizontally disposed surface, the rebound corridor extends angularly upwardly to a level above the hopper for return of abrasive particles by gravity from the rebound corridor to the hopper.

3. An apparatus as claimed in Claim 2, which includes an air wash between the ends of the rebound corridor and the hopper for removal of fines and dust from the abrasive particles before return to the hopper.

4. An apparatus as claimed in any preceding Claim, in which the blast opening is located in the bottom side of the housing.

5. An apparatus as claimed in any preceding Claim, in which the blast corridor extends at an angle within the range of 30-80° to the surface.

6. An apparatus as claimed in Claim 5, in which the rebound corridor extends at an

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angle of 0-15° less than the mirror, angle of the blast corridor.

7. An apparatus as claimed in any preceding Claim, which includes auxiliary surface cleaning means rearwardly of the blast opening for removal of particles remaining on the surface beyond the blast opening.

8. An apparatus as claimed in Claim 2 or any one of Claims 3 to 7 when appended to Claim 2, in which the rebound corridor extends angularly upwardly through an angle of at least 180° from the horizontal whereby the abrasive particles fall gravitationally from the end of the corridor.

9. An apparatus as claimed in Claim 8, in which the rebound corridor extends upwardly at a backward angle to a level above a hopper whereby the end of the corridor extends at a downward angle in the direction towards the hopper.

10. An apparatus as claimed in any preceding Claim, in which the rebound cor-

ridor decreases in cross-section from the inlet end portion to the outlet end portion whereby the velocity of air flow through the corridor increases from the inlet end portion to the outlet end portion.

11. An apparatus as claimed in any preceding Claim, in which the rebound corridor terminates in a reverse end portion which extends angularly downwardly.

12. An apparatus as claimed in any preceding Claim, comprising sealing means around the periphery of said opening to retard the escape of spent abrasive from said housing.

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