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F. B. WALDRON
 APPARATUS FOR PRODUCING A GROUND OR GROUND AND
 POLISHED CONTINUOUS STRIP OF GLASS
 Filed Oct. 8, 1943

2,348,581

2 Sheets-Sheet 1

FIG. 1.

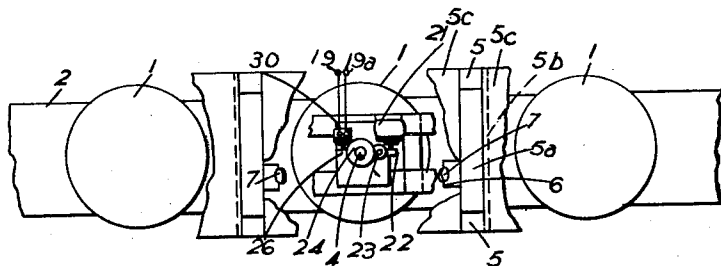
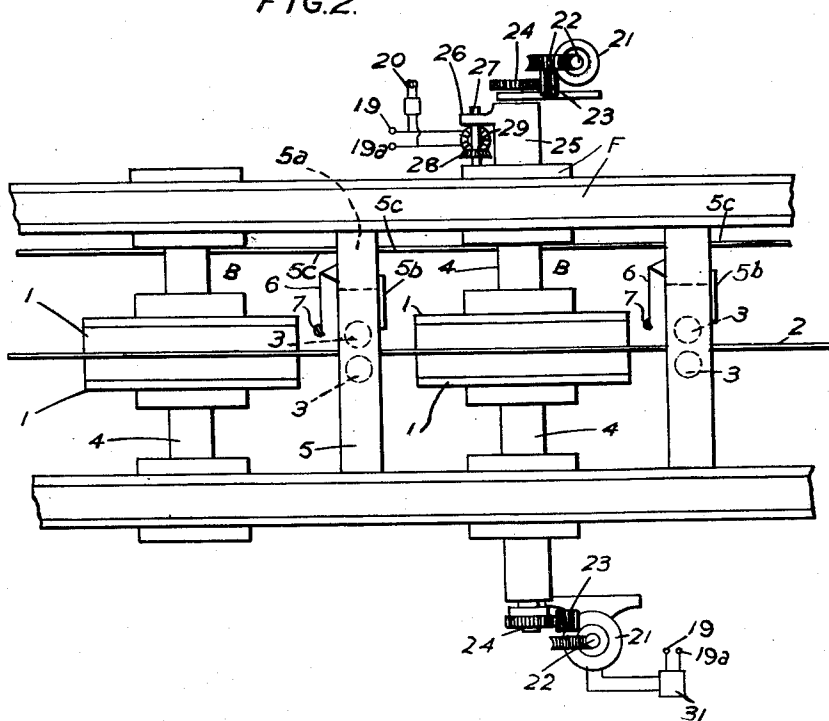


FIG. 2.



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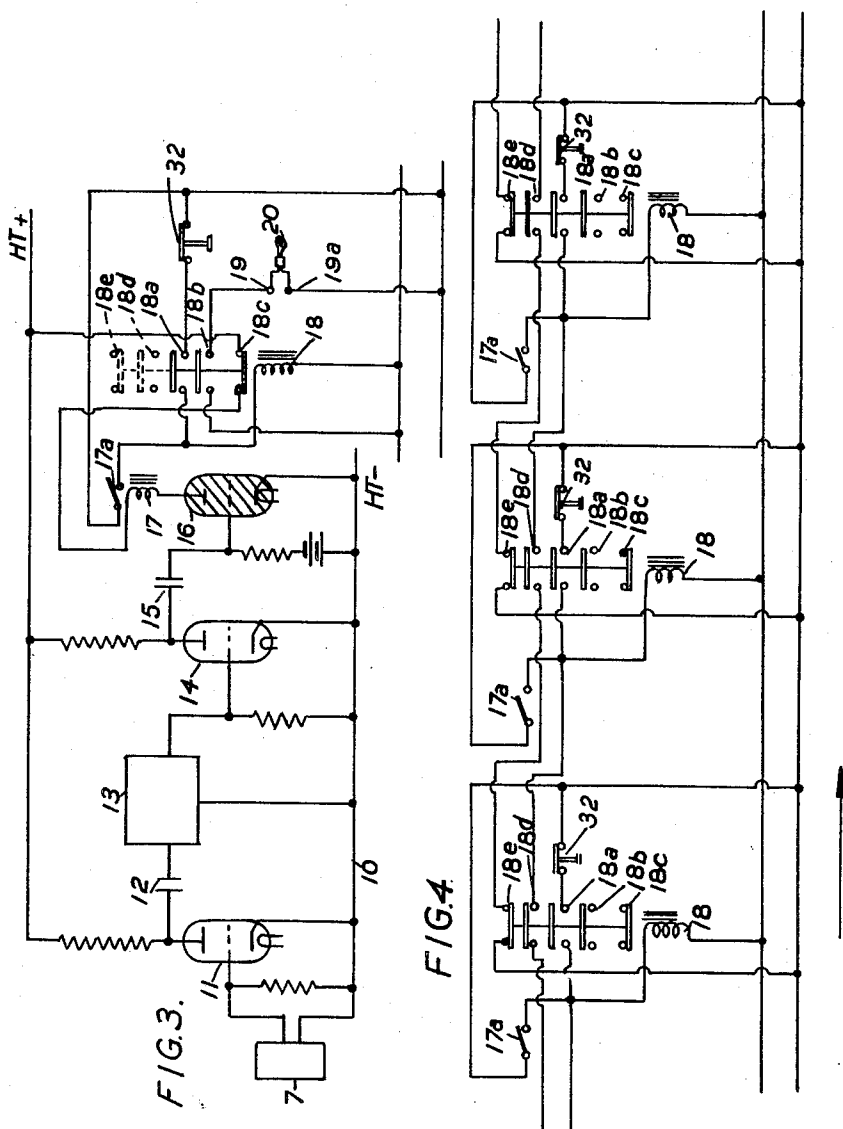
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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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APPARATUS FOR PRODUCING A GROUND OR
GROUND AND POLISHED CONTINUOUS
STRIP OF GLASS

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5 Claims. (Cl. 51—112)

This invention relates to apparatus for pro-
ducing a ground or ground and polished contin-
uous strip of glass.

In the type of apparatus to which the inven-
tion is applicable, a strip of glass is formed from
molten glass in a tank, is passed through a Lehr
and then through a grinding apparatus followed,
if the strip is to be polished, by a polishing ap-
paratus. In the grinding and polishing appa-
ratus driving rollers are provided for driving the
glass forward in a linear path, the rollers being
spaced along said path and the tools are in co-
axial pairs, usually one pair between each pair
of driving rollers, the two tools of each pair op-
erating opposite to each other on the upper and
lower surfaces of the strip. The lower tools are
usually adjusted in height so that the series of
tools form a plane surface on which the strip
rests, while the upper tools are provided with
manually controlled devices adapted when oper-
ated either to raise a tool from, or to lower a
tool down on to, the strip.

The strip is normally continuous from the
forming apparatus to the further end of the
grinding or grinding and polishing apparatus,
but from time to time the strip cracks across in
its passage through the apparatus. The fact of
the strip being non-continuous by reason of such
a crack does not per se interrupt the continuous
operation of the apparatus, because the strip is
driven through the apparatus by pairs of rollers
between each pair of tools, and the two lengths
of strip are driven independently through the
apparatus.

In the processes of grinding and polishing a
continuous strip of glass in which both surfaces
are ground or polished simultaneously, it is of
the utmost importance that the occurrence of a
crack in the glass should be ascertained within
a very short time. If a length of glass following
a crack is allowed to reach a pair of grinding
tools, the glass is broken up and a considerable
quantity is wasted. If it is allowed to reach a
pair of polishing tools, the polishing felts are
damaged by the sharp edges of the glass. More-
over if a crack occurs in the length of glass be-
ing operated on by a pair of tools, the glass is
liable to be broken up or the polishing felts are
liable to be damaged.

The main object of the present invention is a
device whereby an operating tool in the vicinity
of a crack may be raised, either manually or
automatically in the shortest possible time after
a crack has started.

It has been found that the cracking of a strip

of glass in a grinding and polishing apparatus
emits a noise consisting of a damped wave train
of short duration of frequencies higher than
those in the bulk of the general noise of the
grinding and polishing apparatus, but that this
general noise does contain continuous waves of
frequencies of the same order as those emitted
by the cracking glass, but of lower intensity.

According to the invention a method of con-
trolling machinery used in grinding or polishing
simultaneously the two surfaces of glass in con-
tinuous strip form, consists in utilising the brief
train of sound waves emitted by the cracking of
the glass to operate a microphone device which,
when set into vibration, emits an electrical im-
pulse to a relay, the relay being employed to
operate an automatic device for raising a tool
operating on the upper surface of the glass or to
operate a signal device to draw the operator's
attention to the existence of the crack in the
glass, or both; the microphone device being of
low inertia adapted to respond to a brief train of
sound waves of frequencies of the order of those
emitted by the cracking of the glass, but not to
respond to sounds of other frequencies accom-
panying the processes of grinding and polishing,
and being adjusted in sensitivity so as not to re-
spond to the low intensity sounds accompanying
the said processes which are of frequencies of the
order of those emitted by a crack.

The vibratory element may be comprised in a
microphone which is tuned to respond to the de-
sired band of frequencies and, when set in vibra-
tion operates a relay such as a grid controlled
gas-filled valve. Alternatively the microphone
may respond to frequencies other than those of
the desired band and may supply varying cur-
rent to an electric circuit adapted substantially
to cut out frequencies below those of the desired
band, or may supply the varying current to a
valve amplifier adapted to amplify the desired
band of frequencies. The filtered or the ampli-
fied electrical impulse resulting from the sound
wave emitted by the crack is caused to operate
a relay. The term "cut out" is intended to in-
clude reducing to an intensity which can be
neglected.

The relay may operate an automatic device
to raise one or more of the grinding or polishing
tools operating on the upper surface of the glass,
in the neighbourhood of the crack, so as immedi-
ately to raise them from the glass, and prefer-
ably also to stop immediately the rotation of the
lower tools, and if desired the upper tools also.

In one preferred embodiment, a series of

microphones or microphone devices are placed near the glass at intervals along the strip, and the intervals are conveniently given the same spacing as the spacing of the tools.

Each vibratory element employed must be of small enough inertia to respond adequately to the brief train of sound waves of high intensity, and then the sensitivity of the device may be adjusted so that it does not respond to the cumulative effect of the continuous wave of high pitch forming part of the general noise.

The response to the sound of a crack may, generally, be restricted to a single one of the series of microphone devices by adjusting the sensitivity of the devices and by acoustic screening between adjacent microphones. In some constructions the grinding or polishing apparatus comprises frames carrying the driving rollers and supporting the superstructure, these frames dividing the apparatus into successive bays in which the tools operate, each frame carrying also a vertical curtain to prevent rouge from splashing over from one bay to the next, and each bay being decked over horizontally. In apparatus of this form the microphones, placed one in each bay, are, to a great extent, screened from one another by the driving rollers and their frames and by the curtains and decking.

If desired the circuits of the microphones may be so interconnected that energisation of the relay associated with one microphone renders effective the means for energising the relay associated with the next succeeding microphone and maintains ineffective the means for energising the relay associated with the next microphone but one, whereby the response of one microphone causes the raising of the tool associated with the microphone which has responded and also the next succeeding tool, but not subsequent tools.

In order that the invention may be more fully understood one embodiment thereof will now be described by way of example with reference to the accompanying diagrammatic drawings.

In the drawings:

Figure 1 illustrates in plan one form of polishing installation according to the invention, for use in surfacing plate glass of 6 to 7 mm. thick;

Figure 2 shows in elevation and to a larger scale two adjacent bays of the installation, each containing a pair of tools and a microphone;

Figure 3 is a diagram of the electrical control circuit associated with one microphone employed in the installation shown in Figures 1 and 2, and

Figure 4 shows a circuit whereby response of a microphone in one bay raises the upper tool in that bay and also the tool in the next succeeding bay, but not the tools in subsequent bays.

In the drawings like references designate the same or similar parts.

In the construction shown in Figures 1 to 3 the installation comprises a plurality of equally spaced co-axial pairs of polishing tools 1 of known form of which three pairs are indicated in Figure 1 and two pairs only shown in Figure 2 and pairs of rollers 3 (Fig. 2) for driving the glass strip 2 in a horizontal path between the pairs of tools, the rollers being spaced along said path. Only the upper tool 1 of each pair is visible in Figure 1, the lower tool being on the lower side of the strip 2 immediately below the upper tool.

Each tool 1 is rotated by a vertical shaft 4 and the shafts of the two tools of a pair are in line.

Each pair of rollers 3 is carried in a fixed vertical portion of the framework of the apparatus,

said vertical portion including two columns 5 and a transverse member 5a, successive vertical portions of the framework dividing the apparatus into successive bays B (Figure 2) in each of which there is disposed a pair of rotating tools 1.

In each bay B there is hung from the transverse member 5a, by means of a known form of suspension indicated at 6 in Figure 2, a microphone 7 directed inwardly of the bay, the suspension being such as to dispose the microphone as near as possible to the glass strip, and the spacing of the microphones being the same as that of the tools.

Extending across the columns 5 of each bay is a vertical curtain 5b and each bay is also provided with horizontal decking, indicated at 5c.

Each of the microphones indicated at 7 is of small enough inertia to respond adequately to the brief train of sound waves of high intensity emitted by the cracking of the glass, and controls the supply of current to the electrical circuit shown in Figure 3 which, as described later, includes a filter 13 adapted to cut out frequencies below 1500 cycles per second and to pass frequencies of the order of those of the sound of glass cracking in the installation.

The microphone 7 is adjusted in sensitivity so as not to respond to the low intensity sounds accompanying the process of polishing which are of frequencies of the order of those emitted by a crack.

Experiments have shown that by employing a microphone which responds to a frequency above 1500 cycles per second with an electrical circuit adapted to cut out frequencies below 1500 cycles per second, the device when suitably adjusted in sensitivity will respond to the noise of a crack and not respond to the general noise of a grinding and polishing operation.

Accordingly the microphone 7 with valve circuit and filter 13 together constitute a microphone device adapted to respond to the brief train of sound waves of frequencies of the order of those emitted by the cracking of the glass but not to respond to the sounds of other frequencies accompanying the grinding and polishing process and adjusted in sensitivity so as not to respond to the low intensity sounds accompanying the said process which are of frequencies of the order of those emitted by a crack.

Each microphone circuit may conveniently be arranged as shown in Figure 3.

One terminal of the microphone 7 is connected to the negative high tension line 10 and the other terminal to the grid of a first amplifying valve 11 of which the anode is connected through coupling condenser 12 and the filter 13 to the grid of a second amplifying valve 14.

Through coupling condenser 15 the anode of valve 14 is connected to the grid of a grid controlled gas filled valve 16 controlling the circuit of a relay coil 17, the grid of said valve being biased to render the valve normally non-conductive.

The normally open relay contacts 17a are in the circuit of a contactor coil 18 and serve, when closed, to complete the circuit from the A. C. mains through the contactor coil.

The contactor includes normally open contacts 18a, which, when closed establish a holding circuit for the coil 18, normally open contacts 18b controlling the supply of current to a pair of terminals 19, 19a across which may be connected an electrical device for giving an indication of the presence of a crack in the glass strip 2, and normally closed contacts 18c in series with the relay

coil 17 in the anode circuit of the gas filled valve 16.

When the sound of glass cracking in the installation is picked up by the microphone 7 the resulting electrical impulse, amplified by the valve 11 is passed by the filter 13 to the second amplifying valve 14 whence it reaches the grid of the gas filled valve 16.

The characteristic of the valve 16 is such that the amplified impulse from the microphone causes the valve to fire and conduct current, which continues to flow after the impulse from the microphone has ceased. This current energises relay 17 which closes its contact 17a thereby establishing the circuit through contactor coil 18 which closes its contacts 18a and 18b and opens its contacts 18c.

Closure of contacts 18a establishes the holding circuit for the contactor coil 18 and closure of contacts 18b energises the circuit containing the terminals 19, 19a, while opening of contacts 18c breaks the anode circuit of the gas filled valve 16 so that the current flow through this valve and the relay coil 17 ceases. Contactor coil 18, however, remains energised through the holding circuit which is maintained through contacts 18a.

It will be understood that the arrangement must be such that the contacts 18a close to establish the holding circuit for the contactor coil 18, before the contacts 18c open to break the anode circuit of the valve 16.

The electrical device which is connected across the terminals 19, 19a, may be a lamp 20 as shown in Figures 1 and 3 for giving a visual indication of the presence of the crack, or it may be a device for giving an audible indication. Thereby the operator is advised of the position of a crack as soon as it occurs and is able quickly to raise the upper tool operating on the length of glass in the bay in which the crack is, and to stop the operation of the lower tool. Similarly an operator can, on hearing or seeing a signal, relieve the pressure applied to the glass by the top rollers of a driving pair disposed between the operating tools.

Preferably, however, as also shown in Figures 1 and 3, the relay 17 in addition to or instead of controlling a signal, for example the lamp 20, serves to control automatic means for raising the upper tool from the glass strip 2.

Each shaft 4 carrying the upper and lower tools is, in the example shown, driven in the usual manner from an independent motor 21 through worm gearing 22, a pinion 23 and a spur wheel 24 secured to the associated driving shaft 4 (see Figures 1 and 2).

The upper tool is provided in the known manner with automatic means for raising it clear of the glass, and a motor driven form of automatic means is shown diagrammatically in Figures 1 and 2 wherein the shaft 4 for the upper tool is mounted in a sleeve 25 which is disposed to slide vertically on the fixed frame F and carries a lateral extension 26 having an internally screw threaded bore with which engages a screw threaded spindle 27 of which the lower end bears on the frame F. Secured to the spindle 27 is a bevel wheel 28 meshing with a bevel wheel 29 secured to the shaft of a motor 30 (Figure 1).

In order to operate the raising means automatically immediately a crack is detected by the microphone 7, the motor 30 is connected in series with the terminals 19, 19a, so that when the contacts 18b controlled by coil 18 close due to a crack in the glass, the motor 30 revolves so as to rotate

the spindle 27 in a direction to raise the sleeve 25 and therefore the upper tool 1 clear of the glass strip 2.

The usual safety switch is provided in the motor circuit which is opened when the sleeve 25 reaches the limit of its travel.

The terminals 19, 19a may also be connected to a contactor switch 31 (Figure 2) serving to control the current supply to the driving motor 21 for the lower tool in such a way as to stop the rotation of the lower tool by cutting off the current supply to its motor when the circuit of the terminals 19, 19a is interrupted.

When the apparatus is ready for starting again the operator de-energises the contactor coil 18 by opening a resetting switch 32 which is preferably of the press-button type. Thereupon contacts 18a and 18b open and contacts 18c close, so that upon release of the press button switch 32 the relay circuits are restored to normal condition, in which they are again available for operation.

In a modified arrangement the first amplifying valve 11 and the filter 13 may be replaced by a valve amplifier tuned to frequencies of the order of those of the sound of glass cracking in the installation.

In an alternative modification, the microphone device may comprise, instead of the microphone 7 and filter 13, a microphone which is tuned to respond to the band of frequencies of the sound of cracking glass and not to low frequencies, in which case the filter 13 will be dispensed with, the microphone being connected through amplifying valves such as 11 and 14 to the gas filled valve 16.

Where automatic motor driving means is provided for raising the upper tools each contactor 18 may include two further contacts shown in chain lines at 18d and 18e in Figure 3, and in full lines in Figure 4. The contacts 18d, normally open are in series with the contacts 18e of the contactor 18 in the preceding bay B, and this circuit shunts the relay contacts 17a associated with the microphone 7 in the next succeeding bay.

On energisation of a coil 18 associated with any bay B in which a crack has occurred the contacts 18d will close and, through contacts 18e of the contactor for the preceding bay, will energise the coil 18 for the next succeeding bay whereby the upper tool raising motor for said next succeeding bay will be actuated as well as the motor for raising the upper tool in the bay in which the crack has occurred. By this means damage to the polishing felts in the next succeeding bay B due to the broken glass reaching them, before the operator has had time to operate the tool raising motor personally, is avoided.

Energisation of coil 18 in the next succeeding bay will, of course, close the associated contacts 18d but this is prevented from energising the coil 18 in the next bay but one by the opening of contacts 18e of the contactor associated with the bay in which the crack has occurred, which contacts 18e are in series with the contacts 18d of the contactor in the next succeeding bay. Accordingly only the tools in the bay in which the crack has occurred and in the next succeeding bay are raised, the remaining tools being unaffected.

By the present invention apparatus is provided which is adapted to prevent damage arising out of a crack in the glass, since a tool over or contiguous to the crack may be raised very soon after the crack occurs, and thereby a visible indication of the existence of a crack is called to the attention of an operator, although as herein referred to, an audible signal may also be caused to occur.

I claim:

1. A method of controlling machinery used in surfacing simultaneously the two surfaces of glass in continuous strip form, consisting in utilising the sound waves emitted by the cracking of the glass to operate a low inertia microphone device which, when set into vibration emits an electrical impulse to a relay, the relay being employed to operate an automatic device for giving an indication of the existence of a crack in the glass, restricting the response of the microphone device to frequencies of and above the order of those emitted by the cracking of the glass, and adjusting the sensitivity of the device so that it does not respond to the low intensity sounds accompanying the said process which are of frequencies of the order of those emitted by a crack.

2. Apparatus for controlling machinery used for surfacing glass, of the kind wherein a continuous strip of glass travels between a plurality of pairs of rotary tools operating simultaneously on the two surfaces of the strip, comprising in combination a microphone device responsive to sound waves of frequencies emitted by the cracking of the glass, but not to the sound waves of lower frequencies emitted by the surfacing process, and of a sensitivity insufficient to allow it to respond to the low intensity sound waves emitted by the said process which are of frequencies of the order of those emitted by a crack, a relay, electrical connections between the microphone device and said relay whereby the relay is controlled by electrical impulses emitted by the microphone device and means operative under the control of the relay, when energised, to give an indication of the existence of a crack.

3. An installation for surfacing glass of the kind wherein a continuous strip of glass travels between a plurality of pairs of rotary tools operating simultaneously on the two surfaces of the strip, and including power driven means for raising each upper tool from the glass, comprising in combination a plurality of microphone devices, each including a microphone, said microphones being placed near the glass at intervals along the strip and said intervals being given the same spacing as the spacing of the tools, acoustic screening means disposed between adjacent microphones for restricting the sound of a crack to a single one of said microphones, a relay appropriated to each microphone device, electrical connections between each relay and its appropriated microphone device whereby each relay is controlled by impulses emitted by said microphone device, means actuated by each relay, when energised to set into operation the power driven means for raising from the glass the tool appropriated to said relay, an electrical connection between the relay appropriated to one microphone and the relay appropriated to the next succeeding microphone such that energisation of one relay effects energisation of the next succeeding relay also, and an electrical connection between each relay and the next relay but one such that energisation of one relay renders ineffective the next relay but one, whereby the response of one microphone causes the raising of the upper tool appropriated to the microphone which has responded and also the next succeeding tool, but not subsequent tools, each of the microphone devices being of low inertia adapted to respond to sound waves of frequencies of the order of those emitted by the cracking of the glass, but not to respond to sounds of

other frequencies accompanying the surfacing process, and being adjusted in sensitivity so as not to respond to the low intensity sounds accompanying the said process which are of frequencies of the order of those emitted by a crack.

4. An installation for surfacing glass of the kind wherein a continuous strip of glass travels between a plurality of pairs of rotary tools operating simultaneously on the two surfaces of the strip and including in combination a framework having successive fixed vertical portions spaced along the path of the glass and dividing the apparatus into successive bays, a pair of horizontal rollers carried in each vertical portion of the framework, said rollers serving to drive the glass forward in a linear path, a curtain carried by each vertical portion of said framework and extending above the rollers, horizontal decking extending between adjacent vertical frame portions to form a covering to the bay constituted therebetween, a pair of rotating surfacing tools disposed in each bay, the tools of each pair operating the one on the upper face and the other on the lower face of the glass, and means for driving said tools, a microphone device to each bay and including a microphone located within the bay and facing a free area of the glass strip, a relay appropriated to each microphone device, electrical connections between each relay and its appropriated microphone device whereby the relay is controlled by electrical impulses emitted by the microphone device, and means operative under the control of each relay to give an indication of the existence of a crack, each of the microphone devices being of low inertia adapted to respond to sound waves of frequencies of the order of those emitted by the cracking of the glass, but not to respond to sounds of other frequencies accompanying the surfacing process, and being adjusted in sensitivity so as not to respond to the low intensity sounds accompanying the said process which are of frequencies of the order of those emitted by a crack.

5. An installation for surfacing glass of the kind wherein a continuous strip of glass travels between a plurality of pairs of rotary tools operating simultaneously on the two surfaces of the strip and including in combination a framework having successive fixed vertical portions spaced along the path of the glass, and dividing the apparatus into successive bays, a pair of horizontal rollers carried in each vertical portion of said framework, said rollers serving to drive the glass forward in a linear path, a curtain carried by each vertical portion of said framework and extending above the rollers, horizontal decking extending between adjacent vertical frame portions to form a covering to the bay constituted therebetween, a pair of rotating surfacing tools disposed in each of said bays the tools of each pair operating the one on the upper face and the other on the lower face of the glass, means for driving said tools, and power driven means for raising each upper tool from the glass, a microphone device to each bay and including a microphone located within the bay and facing a free area of the glass strip, a relay appropriated to each microphone device, electrical connections between each relay and its appropriated microphone device whereby the relay is controlled by electrical impulses emitted by the appropriated microphone device, and means actuated under control of each relay, when energised, to set into operation the power driven means for raising from the glass the

upper tool in the appropriated bay, an electrical connection between the relay appropiated to one microphone and the relay appropriated to the next succeeding microphone such that energisation of one relay effects energisation of the next succeeding relay also, and an electrical connection between each relay and the next relay but one such that energisation of one relay renders ineffective the next relay but one, whereby the response of one microphone causes the raising of the upper tool appropriated to the microphone which has responded and also the

next succeeding tool, but not subsequent tools, each of the microphone devices being of low inertia adapted to respond to sound waves of frequencies of the order of those emitted by the cracking of the glass, but not to respond to sounds of other frequencies accompanying the surfacing process, and being adjusted in sensitivity so as not to respond to the low intensity sounds accompanying the said process which are of frequencies of the order of those emitted by a crack.

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