

Nov. 8, 1960

R. J. ANDERSON

2,959,174

CORN SHELLER HAVING AUTOMATIC ROTOR DEACTIVATOR

Filed Sept. 17, 1956

2 Sheets-Sheet 1

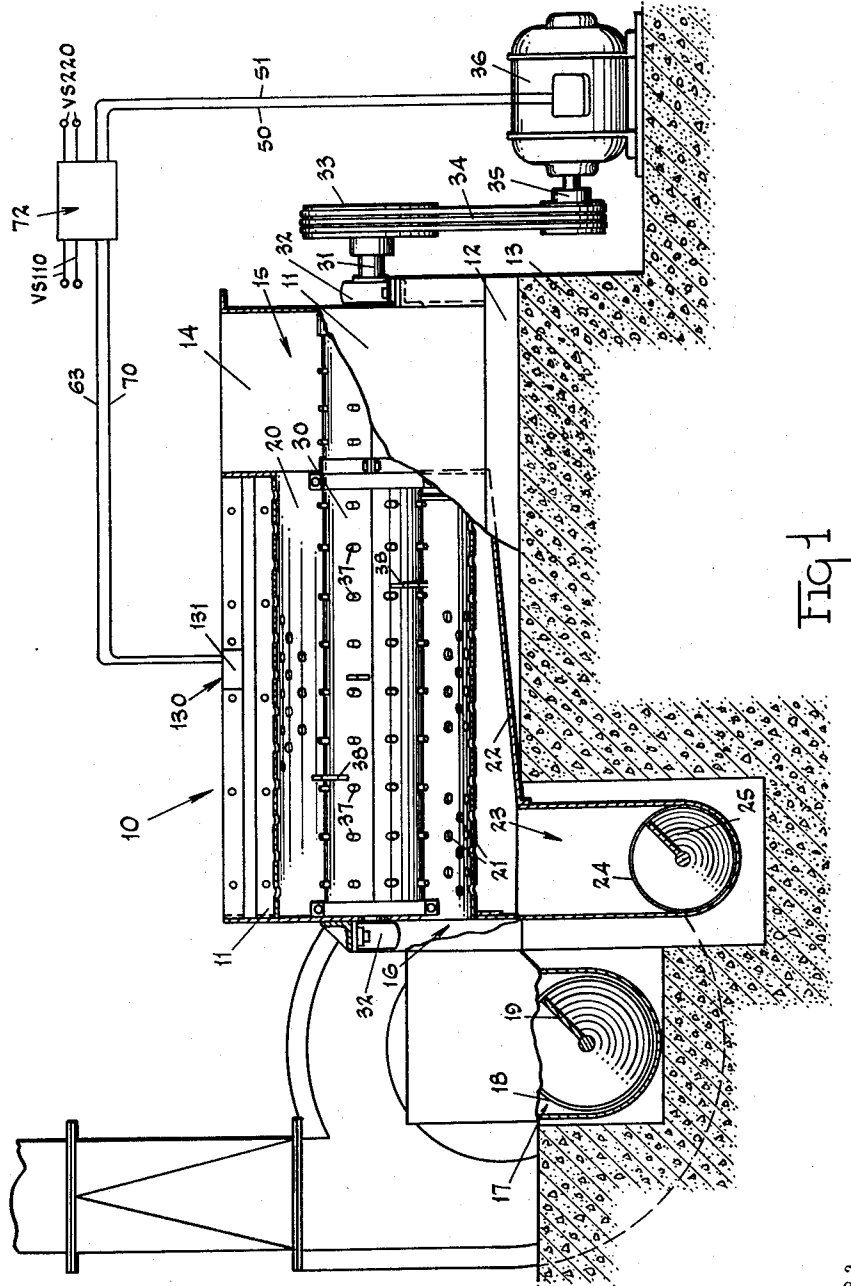


FIG. 1

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2 Sheets-Sheet 2

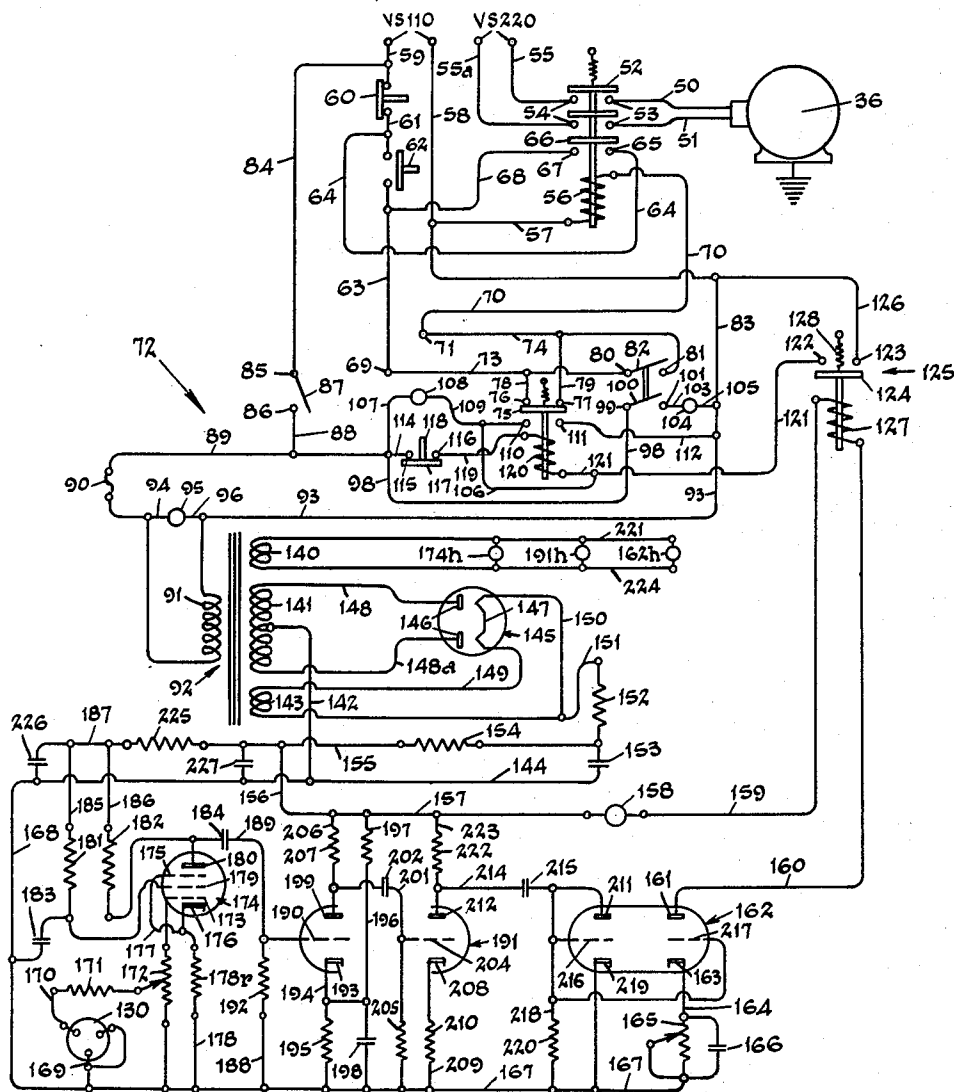


Fig 2

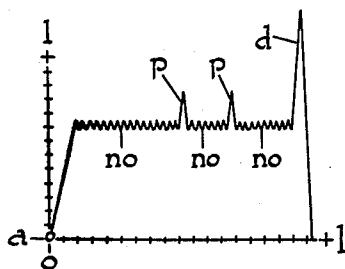


Fig 3

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2,959,174

**CORN SHELLER HAVING AUTOMATIC ROTOR
DEACTIVATOR****Robert J. Anderson, Toledo, Ohio, assignor to The Ander-
sons, Maumee, Ohio, a partnership of Ohio****Filed Sept. 17, 1956, Ser. No. 610,343****3 Claims. (Cl. 130—6)**

Generally, my invention concerns machinery for shell-
ing corn. The invention particularly relates to a control
system therefor.

Sheller machinery operates to remove the kernel from
the cob by rubbing the grain from the cob. The ma-
chines have nested and spaced outer and inner elements,
one only of which is usually made to rotate relative to
the other and are known as cylindrical type shellers.
The ears of corn are introduced between the elements
of the cylindrical type sheller and a certain amount of
desirable congestion of the corn ears is produced be-
tween the elements. The congestion is obtained either
by crowding the feed of ear corn, by checking the cob
discharge or, in certain kinds of cylindrical shellers, by
providing the elements with a degree of flare which pro-
duces a gradually decreasing throat between the elements
into which the ears of corn crowd.

The congestion of the ear corn is desirable because
such congestion produces kernel removing rubbing be-
tween the ears. The modern sheller now found in grain
elevators in this country with which I am most familiar
has elements of cylindrical form, one being usually a
reticulated cage, sometimes called a shelling stave, con-
cave or screen, and the other, usually called the shelling
rotor or cylinder, being a rapidly rotated central core
cylinder extending coaxially through the cage and bear-
ing radially extending lugs and sometimes teeth for mov-
ing the kernel bearing cobs into and through the kernel
stripping congestion within the screen. Such equipment
is described and shown in the United States Letters Pat-
ents Nos. 2,271,898 and 2,754,827. It is this kind of
equipment that I will use to describe and explain my in-
vention and its use.

Ear corn is usually fed to the corn sheller as it is re-
ceived from the growing fields. Such corn usually having
been mechanically picked, often contains foreign mat-
erials such as rock and tramp iron. There is very little,
if any attempt made to separate these foreign materials
from the harvested corn before it enters the sheller. As
a consequence, the sheller often receives such foreign
materials as part of its charge. The charge is usually
introduced to the sheller space between the elements by
a gravity flow hopper feed. Of course, some foreign
materials in the charge are of such insignificant displace-
ment or mass that they pass easily between the elements
or, though set in motion by the relative moving of one
sheller element, will develop only minor momentum or
exert such inertia or impact with the elements as to have
little or but slight effect on the sheller elements. These
foreign materials could be considered as "digestible" in
a sense, because they are not injurious to and easily pass
between the sheller elements. On the other hand, other
foreign materials entering the space between the elements
have a displacement which may bridge the space between
the sheller elements or have a mass which when set in
motion by the moving of the moving sheller element de-
velops a momentum or exerts an inertia which on impact

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with a sheller element may cause a serious dent or break-
age of the element. These foreign materials are not what
can be called digestible and are injurious to the sheller
elements. Examples, in field stone, of a digestible and
non-injurious foreign material in a sheller like that shown
in United States Patent No. 2,754,827 of current use
would be a stone having about one and one-half inch
diameter weighing approximately three ounces. On the
other hand, a field stone weighing fourteen ounces and
having a displacement of say three by three by one inches
proves to be indigestible and would be injurious to the
sheller elements, if allowed to remain in the sheller.

It has not been found economically feasible to cull all
indigestible foreign materials from the charge of ear corn
preliminary to its introduction to the sheller. Instead,
the attack on the problem has been to attempt extraction
during the grain and cob separating or in the subsequent
kernel or cob conveying and treating processes.

However, the presence of the indigestible foreign ma-
terials in the sheller during the earlier shelling process
often produces considerable damage to the elements and
may require a shut down of the sheller for long out-of-
service periods during critical times. It is my experience,
therefore, that the presence and removal of such foreign
materials in the shelling process and promptly after they
make their presence known is required.

My invention is directed to provision of a means for
locating the foreign materials likely to be injurious to a
corn sheller elements of corn shelling machinery during
the shelling process. The invention has for its broad
object to provide a means for detecting foreign materials
likely to be injurious to the sheller elements and for dis-
continuing the sheller drive, automatically on such detec-
tion. This allows the machine operator to remove the
offensive foreign materials before any damage has be-
come extensive and thereafter to proceed with corn
shelling.

Heretofore, reliance upon the experience and percep-
tion of the machine operator to note the telltale sound
indicating the presence of indigestible foreign materials
in the machine charge has been depended on. Very often
where only one machine is operating and the operator
can move swiftly enough to the machine control, to stop
the machine, reliance upon the operator's hearing and
experience has been sufficient. However, where a battery
of machines are being used, as is often the case in com-
mercial establishments, and the machine operator must
attend to other related duties besides listening for tel-
tale sounds dependance upon the ear and judgment of
the operator in such circumstances often results in dam-
aging delay before the machine having the offending
foreign material can be shut down. My invention places
a mechanical guardian over each machine which, within
the range of mechanics, exercises infallible judgment as
to when to shut down the machine under its guardian-
ship in the presence of foreign materials of various size.

A further object of my invention is to provide a con-
trol system for a corn sheller machine comprising rela-
tively rotatable nested and spaced chamber and core ele-
ments, means for rotating one of the elements, an actu-
atable means operatively connected to the element ro-
tating means and on actuation operable to render the
element rotating means inoperative to rotate the element,
said control system including a member operatively con-
nected to said actuatable means and positioned with re-
spect to the elements so as to pick up and be sensitive to
the loudness of the sound issuing therefrom as a conse-
quence of an indigestible foreign material striking an
element and thereupon operative to actuate said actuat-
able means to render the element rotating means inopera-
tive and thus to shut down the machine.

A further particular object of my invention is to provide a control system for a corn sheller of the kind just described in which the loudness sensing member comprises a diaphragm of a microphone and the means operatively connecting the loudness sensing member to the sheller motor control switch includes an electro-magnetic device in balance with and counteractive to a mechanical biasing device, said electro-magnetic device being electrically connected to said microphone and being energized to a degree in indirect proportion to the acoustical displacement of the microphone diaphragm, whereby only those sounds in excess of the range of loudness of normal shelling and passage of digestible foreign materials through the sheller cause that change in current flow through the electro-magnetic means of a degree by which the aforesaid balance condition with said mechanical biasing device is upset causing the sheller motor control switch to open and allowing the sheller to stop. Another particular object of my invention is to teach a method of using a control system of the kind described so that such system may discriminate between sounds caused by foreign materials that do not cause damage or harm to the sheller elements and sounds caused by foreign materials that because of their size or mass do cause damage.

A still further particular object of my invention is to provide a control system for a corn sheller of the kind described having, in addition, a signal means operatively connected to said microphone and operable to make a signal when the microphone effects discontinuance of the sheller drive. This provision, where a battery of shellers is in operation as often occurs in grain elevator operation, is of material importance to the overall efficiency of the operation.

My invention has for further objects those of providing other advantageous structures and arrangement which will appear from the following description and from an examination of the accompanying drawings. Control systems for crop refining machinery containing my invention may take various forms, one of which appears to me, at this time, to be the best mode of carrying out my invention. I shall describe such form and, in doing so, will make reference to the accompanying drawings. However, I do not imply by such description or reference that I am unaware that there are variations therefrom which also embody my invention or that I disclaim such variations as beyond the contemplation of any invention made manifest herein.

Figure 1 of the accompanying drawings illustrates a view of a side elevation of a corn sheller, with which a control system embodying my invention and shown thereon operates to good advantage, portions of the sheller being shown cut away or in section to facilitate illustration.

Figure 2 illustrates diagrammatically the control system embodied in an electric circuit and cooperating with the corn sheller shown in Figure 1 and selected for purposes of illustrating my invention.

Figure 3 illustrates, graph-wise, the conditions of sound loudness present in a corn sheller during its operation and when foreign materials enter and, by impact with the sheller elements, make their presence known.

To illustrate an embodiment of my invention and to describe its uses I show, in Figure 1 of the accompanying drawings, and shall describe herein a sheller 10 widely used by the elevator industry for shelling corn. The method of my invention may be practiced of the sheller 10 and I propose to describe how hereinafter. My invention, however, is equally useful, with none or little change, on shellers other than the herein described and illustrated corn sheller, as those skilled in the art will readily appreciate, upon consideration of the following.

The sheller 10

The machinery shown in Figure 1 of the accompanying drawing has an elongated, nearly cylindrical housing

hood 11 whose lower edges 12 are anchored to and rest upon a suitable concrete bed 13.

Within the hood 11 are the sheller elements common to a cylindrical corn sheller. These elements comprise a cylindrical shelling stave or concave 20 and a shelling cylinder 30 disposed in concentric nested relation, with the concave 20 outermost. The charge of ear corn to be shelled enters the interior of the hood 11 usually from a hopper through an opening 14 in the hood which leads into a chamber 15 in communication with the interior of the concave 20.

The shelling concave 20 is a reticulated body having a plurality of holes 21 distributed throughout its lateral wall and for that reason the concave is sometimes called a "screen." It is through these holes that the kernel corn, when removed from its cob, moves to separate the grain from the cob. Below the concave 20 and so as to catch the kernel corn as it falls through the openings 21 is an inclined grain floor 22 which leans toward and directs the falling grain toward a chute 23. The chute 23 communicates with a conveyor passageway 24 in the bed 13. A suitable power driven worm 25 may operate in the passageway 24 to convey the grain to another place, such as to storage or bagging zones.

In addition to fulfilling the function of screening the grain from the cob, the concave 20 also cooperates with the shelling cylinder 30 in releasing the kernel corn from its cob. In this operation, the concave 20 provides a restraint on the ear corn from which a desired congestion of the ear corn occurs to cause neighboring ears in the congested mass to rub each other and, in such rubbing, to strip the kernels from the cobs. The shelling cylinder 30 aids in producing the mentioned congestion and in addition supplies the forces which cause motion of the ears in the congested mass.

The shelling cylinder 30 can be most aptly described as a rotatable drum. It extends not only through the concave 20 but also into and through the chamber 15 of the hood 11. The shelling cylinder has a drive shaft 31 supported in journals 32 and mounting a driving pulley 33 on one end. The pulley 33 is operatively connected by a belt 34 to a drive pulley 35 on a sheller driving electric motor 36. The cylinder 30 has plurality of lugs 37 disposed at spaced points along and around its major longitudinal axis. These lugs 37 extend radially relative to the major longitudinal axis of the shelling cylinder and toward the inner surface of the concave 20. The lugs in the rotation of the cylinder 30 essentially serve to "stir" the ear corn in the regions of their passage and to retard a too rapid movement of the ear corn charge through the concave. Sometimes teeth, like those indicated at 38, are provided on the cylinder. These teeth 38, in the region of the chamber 15, may serve to urge the charge of ear corn horizontally and into the concave 20.

Rotation of the shelling cylinder 30 occurs at a high rate of speed. Some authorities recommend rotation speeds between 500-600 r.p.m. Rotation at these speeds tends to give the charge of ear corn a centrifugal impetuous toward and against the concave 20 with a consequent and desired kernel removing congestion, previously mentioned.

As the kernels are removed from the cob, the congestion becomes relieved somewhat and more and more open space within the concave occurs. It is through this space that bodies may be projected. Eventually, the stripped cobs pass from the concave 20 through an end opening 16 in the hood 11 and into a chute 17. The chute 17 may communicate with a passageway 18 in which a power driven rotatable conveyor worm 19 may be supported. The worm 19 moves the cobs to other places where, for example, they may be ground or burned.

It is about at this point that most authorities propose to remove foreign materials. My experience indicates that often removal at this point occurs too late and after

damage has been done to the sheller. I have found that just as soon as shelling progresses to a point that congestion is relieved due to the removal of some grain, the foreign materials are driven by the fast moving shelling cylinder 30 to fly through the space formerly occupied by the charge and to impinge against the concave 20 or to ricochet back and forth against the cylinder 30 and concave.

When these foreign materials have certain masses they develop element damaging inertia in such flights. Often, however, before a damage substantial enough to render the sheller inoperative or require its shut down occurs, the flying foreign materials will on hitting the sheller elements 20 and 30 or their parts cause noises which are materially louder than the noise of normal sheller operation or louder than the noise when insignificant and therefore digestible foreign materials hit such elements. This characteristic and their effect, decibel-wise, I attempt to illustrate in Figure 3 of the accompanying drawing. There the abscissal line *a1* indicates, from its intersection, the passage of sheller operation time and the ordinal line *o1* indicates, from its intersection, progressively increasing loudness of noises within the sheller. It will be seen that, after starting, normal operation of the sheller produces a fairly limited straight line range of noises. This is shown by the lines marked *no* on the graph of Figure 3. When a digestible foreign material enters the sheller and is encountered by the sheller elements, the noise or "ping" while louder than normal operation, as indicated at *p* on the graph, it is not as loud as when an indigestible foreign material hits the sheller elements. The louder noise of impact of the dangerous foreign material against a sheller element is indicated at *d* on the graph.

Experienced sheller machinery operators are alert to and can often perceive these revealing dissonances. When they do and are agile enough, they can shut the sheller down before any damage is done. However, when a battery of shellers are operating under the control of a single operator, the problem becomes not only one of perception but also the almost impossible one of distinguishing.

To relieve the operator of such responsibility is one of the objectives of a control system embodying my invention.

The control system

An embodiment of the control system of my invention is diagrammatically illustrated in Figure 2 of the accompanying drawings. Physical parts of the system are shown, some diagrammatically, in Figure 1 of said drawings.

The primary purpose of the control system is to discontinue sheller operation when sounds of *d* (see Figure 3) loudness, indicating the presence of indigestible foreign materials in the sheller, occur in the sheller.

In the form I show and describe here, sheller operation is discontinued by disconnecting the sheller driving motor 36 from its source of power. Those skilled in the art are aware that in place of this, one might with equal facility unclutch the motor 36 from the sheller 10 or set sheller stopping brakes.

In the form shown here, the motor 36 receives energizing current from source VS220 through lines 50 and 51 depending on whether or not the movable contacts of relay 52 are in circuit making position with reference to fixed contacts 53 and 54 thereof. The movable contacts of relay 52 connect lines 50 and 51 with lines 55 and 55a. The operation of relay 52 is made to depend on the energization of the solenoid 56 thereof. The solenoid 56 is connected to a suitable low voltage circuit source VS110 by line 57 leading from one end of the solenoid 56 to line 58 of the source VS110. Leading from such source VS110 is a line 59 connecting with a normally closed, manually operable "stop" switch 60, a

line 61 and then to starting and maintaining circuits arranged in parallel. The starting circuit of the circuits just mounted includes a normally open, manually operable switch 62, and line 63 and said maintaining of said circuits includes line 64 leading from line 61 to auxiliary fixed contact 65 of relay 52, auxiliary movable contact 66 and auxiliary fixed contact 67 of relay 52 and from there to line 68 and back to line 63. Line 63 then joins a terminal contact 69 of what I shall call a "detector" circuit 72. The other end of the solenoid 56 is connected to a second terminal contact 71 of the detector circuit 72 by line 70.

Assuming for the moment that lines 63 and 70 join in the detector circuit 72, one will see that, when the operator depresses starter switch 62, current will pass from source VS110 through the solenoid 56 moving relay 52 to close the circuit between the motor 36 and the source of current VS220 and to also close the circuit of the coil maintaining circuit (64, 65, 66 and 67). The motor 36 begins to operate and, through the belt 34, causes the shelling cylinder 30 to rotate. The release of starter switch 62 will have no effect on continued motor operation because of the circuit maintaining effect previously mentioned. The operation of the sheller 10 continues until either the stop switch 60 is depressed or until the circuit through the joined lines 63 and 70 in the detector circuit 72 is opened.

The sheller motor circuit just described is conventional to most sheller operation circuits. As previously mentioned, in such an arrangement the operator must rely upon his ability to hear the telltale noise of indigestible foreign materials in the sheller 10 and to quickly depress stop switch 60, before damage is done. However, when the detector circuit 72, now to be described, is utilized there is no need for operator attention of this kind.

The detector circuit 72 connects with terminal contacts 69 and 71 through lines 73 and 74, respectively, connected through normally closed relay 75 having fixed contacts 76 and 77 connected to lines 78 and 79 intersecting lines 73 and 74, respectively. The free outer ends of lines 73 and 74 are connected to fixed contacts 80 and 81, respectively, of the double pole, hand operated, throw or knife switch 82. This connection, through the movable contact of switch 82, makes a circuit in parallel to that which includes relay 75. The use of this supplementary circuit will be later explained.

The detector circuit 72 receives power from low voltage source VS110 through lines 83 and 84 which extend from and join lines 57 and 59, respectively. Flow of current through line 84 is subject to operation of switch 87 having fixed contacts 85 and 86. Contact 85 is connected to line 84 and contact 86 to line 88.

Line 88 feeds to four parallel circuits in the detector circuit 72, one of which is closed at all times and the others of which are open, except when switch closed. The closed of these circuits has line 89, fuse 90, primary 91 of a multitap type transformer 92, line 93 to lines 83 and 57 and back to source VS110. In parallel to primary 91, there is a signal circuit having line 94, light 95 and line 96 connected across and between lines 89 and 93. Light 95 lights when switch 87 is closed and therefore serves to signal the fact that the detector circuit 72 is receiving power. The current passing through primary 91 induces current to flow in secondary circuits of the multitap transformer which will be described hereinafter.

One of the three open of the four circuits fed by line 88 is also a signal circuit and includes the double pole knife switch 82. This circuit has line 98 leading from line 88 to fixed contact 99 connected to movable contact 100 of switch 82. When contact 100 engages fixed contact 101 of switch 82, it connects line 98 to line 103. Line 103 connects with signal light 104 in circuit by line 105 with line 83 and return line 58 to the current source

VS110. Thus, when switch 82 is closed through its contacts 80 and 81, current flows through and causes lighting of the signal light 104 and, when switch 62 is pressed, causes current flow through solenoid 56 of the relay 52 to close said relay. This position of the switch 82, for reasons which will later appear, is called the "Hand" operation position and the energizing of the signal light 104 indicates that fact. If desired, a flasher making circuit breaker may be located in either lines 103 or 105 to cause light 104 to flash on and off and thus make a more noticeable signal.

Still another of the three open circuits of the four parallel circuits fed by line 83 is a signal circuit which serves to indicate the abnormally open position of relay 75 in the circuit across lines 73 and 74. This signal circuit leads off from line 83 through line 107, light 108, line 109, normally open fixed contacts 110 and 111 of relay 75 and line 112 to lines 83 and 58 returning to source VS110. When relay 75 closes across contacts 110 and 111, the signal light 108 lights. In operation, as will later appear, signal light 108 lights to indicate that the sheller 10 is no longer being driven by its motor 36.

The last of the three open circuits of the four circuits fed by the line 83 comprises a line 114 leading from line 107, fixed contacts 115 and 116 and movable contact 117 of a manually operable reset switch 118, line 119, solenoid 120 of relay 75, line 121, fixed contact 122 of normally closed plate relay 125 and when closed movable contact 124 and fixed contact 123 of said relay to line 126, line 83, line 58 to source VS110. It will be seen that this circuit is the essential control and lock-out circuit to sheller operation. As long as the relay 125 remains open, the relay 75 remains in circuit closing position in relation to the motor starter coil 56 circuit. When however, relay 125 closes, even momentarily, current flows through solenoid 120 of relay 75, opening the relay 75 and the circuit through the starter coil solenoid 56 is interrupted allowing relay 52 to open the circuit between the motor 36 and its source of current VS220.

A lockout of the relay 75 and the circuit of solenoid 56 it controls, after even a momentary closing of relay 125, is provided by a holding circuit operating to hold the relay 75, when once opened, open. Such holding circuit includes a line 106 extending from line 109 to line 121 and takes a path, when relay 75 bridges fixed contacts 110 and 111 and relay 125 is open, which begins with lines 88 and 114, switch 118, line 119, solenoid 120, lines 121, 106, 109, across contacts 110 and 111, lines 112, 83, 58 to the return side of source VS110.

Relay 125, in the sense that its movable contact 124 is moved to and held in open position by the flow of current through solenoid 127 of the relay 125 against the urgency of a biasing means, such as a spring 128, engaging said movable contact, is a "load and fire" mechanism. The flow of current through solenoid 127 below that necessary to hold the movable contact 124 in circuit open position is made to depend upon the sound excitation of a member such as a diaphragm in a microphone 130 placed relative to the sheller 10 as to be energized by sound emanating from the sheller elements 20 and 30, particularly when indigestible foreign materials are present and come in contact with said elements. The electrical circuit between the microphone 130 and the relay 125, in a sense, provides a trigger link by which the armature moved relay contact 124 may be released to the influence of the distorted spring 128 and thus to close the circuit through the relay 125 with its mentioned consequent result of discontinuance of power to the sheller motor. The function may be preformed equally well by a mechanical means, as by the electrical means I describe and show herein. Also, other electrical elements than those I have selected to embody the electrical means may be used with equal facility though, in some cases, at greater cost.

The microphone 130 is preferably enclosed in a hous-

ing case 131 suitably mounted on the exterior of the hood 11 of the sheller 10. The position of the microphone on the hood 11 in relation to the length along the concave 20 and shelling cylinder 30 is not critical, except that I have found mounting the housing case 131 with its microphone 130 therein about midway the length of the hood 11 produces best results. It is about at this point, in the passage of the batch through the concave 20, that congestion in the sheller batch first becomes relaxed enough to permit relative and substantially free movement of foreign materials which have been previously restrained by such congestion. Thus, it is here that foreign materials, by impacting the sheller elements, most often first make their presence known.

Current by which the solenoid 127 and microphone 130 are energized is induced in secondaries 140, 141 and 143 of the multitap transformer 92. Of the secondaries, the secondary 141 supplies the higher voltage current for rectification by a suitable rectifier, such as the thermoionic diode tube 145 which can be of the 5Y3-GT or the 6AX5-GT trade type. The secondary 141 has a return tap connected to a return line 142 and the plates 146 of tube 145 receive high voltage current from secondary 141 through lines 148 and 148a while secondary 143 supplies filament voltage to the heater-cathode filament 147 of the tube 145 through lines 149 and 150. A pulsating direct current is drawn from filament 147 through line 151 and subjected to desired filtering and choke provided by resistance 152 and condenser 153 in line 151 and resistance 154 in line 155. Condenser 153 connects through line 144 with return line 142 to the secondary 141. From line 155 current flows through lines 156 and 157 to and conveniently through an ammeter 158 and by line 159 to solenoid 127. The current passes through the solenoid 127 and by line 160 to No. 2 plate 161 of a thermoionic twin triode tube 162 across and through to the No. 2 cathode 163 of such tube and by line 164 through a potentiometer 165 with which a condenser 166 is in parallel circuit. The potentiometer 165 enables adjustment of the bias to be overcome by current flowing from the No. 2 cathode 163 to return line 167. Return line 167 connects through line 168 with return line 142. I find that a trade type 6SN7 tube works well to supply the rectifier action required in tube 162, the need of which will soon become apparent.

The microphone 130 connects through line 169 with line 167 and return line 142 and on the other side with the circuit of the solenoid 127 through a simple conventional voltage amplifier hook-up, terminating in the mentioned triode tube 162 of the solenoid 127 circuit. This hook-up originates with line 170, preferably having a fixed resistance 171 and a potentiometer 172 in line and connected to the grid 173 of a thermoionic pentode tube 174. In this arrangement, the suppressor 175 and cathode 176 of the tube 174 are by lines 177 and 178 connected to the return line 167 through resistance 178r, providing fixed bias to the tube 174. The screen 179 and plate 180 of tube 174, each individually by lines 185 and 186, respectively, having resistances 181 and 182, respectively therein, the latter providing load to the plate, are connected with line 187 communicating with line 155 of the heretofore described circuit of solenoid 127. A condenser 183 connects line 185 to return line 168. The tube 174, which is a high gain voltage amplifier and may be a trade type 6SJ7 tube, provides, with bias exerting resistance 182 and cooperating condenser 184 in line 189, high gain voltage amplification in the plate current conducted by the line 189 to No. 1 grid 190 of a thermoionic twin triode tube 191. Thus, the signal from the microphone 130 is coupled to the grid 190.

The grid 190 connects with a grid bias resistor 192 in line 188 which joins return line 167. Tube 191 may be a trade type 6SL7 tube and is wired to connect its No. 1 cathode 193 by line 194 through bias providing resistance 195 to return line 167 and by line 196 to

bias providing resistance 197 and cathode by-pass condenser 198 to line 157 and to line 167. The No. 1 plate 199 of tube 191 connects by line 201 through coupling condenser 202 to No. 2 grid 204 of tube 191 and through grid bias resistance 205 with return line 167. The plate 199 of tube 191 connects also, by line 206 through plate load resistor 207 with return line 157.

No. 2 cathode 208 of tube 191 connects through line 209 with a grid bias source resistance 210 and with return line 167 and No. 2 plate 212 through line 214 and coupling condenser 215 connects with No. 1 plate 211 of tube 162 and with both grids 216 and 217 thereof. The line 214 connects through grid bias resistor 220 with line 218 and with return line 167, as does also the No. 1 cathode 219 of tube 162. No. 2 plate 212 of tube 191 also connects with return line 157 through resistance 222 in line 223. The line 187 may include resistance 225 and connecting condensers 226 and 227 connecting with return line 144 and providing choke filtering to the current flowing to the microphone 130 and tube 174 through lines 187, 185 and 186 from line 155.

It will be seen that tube 162, though a twin triode, is wired as a diode rectifier and, in response to an intense signal from microphone 130, will cause less current flow in the circuit of solenoid 127 permitting the relay spring 128 to dictate closure of the relay 125.

Heat is furnished to the tubes 162, 174 and 191 by heaters 162h, 174h and 191h connected by lines 221 and 224 to the secondary 140 of the transformer 92. Tube 145 has its heater in the cathode structure.

Operation

Assuming that the sheller 10 stands idle, the operator, to start the machine, first closes switch 87. This sends current through the just mentioned tube heater circuit of lines 221 and 224 and through the filament circuit of tube 145 to bring the tubes 145, 162, 174 and 191 into operable condition. The throw switch 82 is then closed, lighting the warning signal light 104, and the starter switch 62 is pushed to close. Current now flows through coil 56 by way of switch 82, whether relay 75 is open or closed. The armature of relay 52 is actuated to close the high voltage circuit from source VS220 to the motor 36 through lines 55, 55a, 50 and 51. Movement of the armature of relay 52 just described also closes the relay holding circuit comprising lines 64 and 68 and contacts 65, 66 and 67. Hence, upon release of the starter switch 62, the relay 52 remains closed as long as its coil 56 continues energized.

When the tubes 145, 162, 174 and 191 have become operative, current flows to the solenoid 127. When this current reaches an excess of a certain amperage the movable armature of relay 125 is actuated against its closing spring 128 to open the circuit controlled by said relay. The gain on the tube 162 connected to the solenoid 127 may be set to any desired level by adjustment of the potentiometer 165. In systems I have operated successfully, where the operation of relay 125 to open occurs at three point six milliamperes, hence I adjust the potentiometer to produce a gain of about six milliamperes, with no signal from the microphone 130. As the tube 162 ages, it is sometimes necessary to further adjust the potentiometer 165 to maintain the gain at a desired level.

Now, the operator adjusts the potentiometer 172 so that the signal transmitted through the hook-up as amplified to the grids 216 and 217 is just too weak to overcome the current flow through relay coil 127. This, on the graph shown in Figure 3 of the accompanying drawings, occurs when the microphone 130 reacts to noises of the value indicated at *no* and *p*. If, perchance, while adjusting potentiometer 172, an over-correction is made and the relay 125 closes, the sheller 10 will not shut down because, as will be remembered, at this time the switch 82 is in its "Hand" operation position maintaining the

circuit of coil 56, notwithstanding interruption of the circuit by operation of relay 75.

Having made the proper adjustment of potentiometer 172, which will in effect be indicated by the ammeter 158 readings, the operator presses switch 118, which interrupts the relay 75 holding circuit by way of line 106 and allows said relay to close. The switch 82 is then manually opened extinguishing light 104 and putting that switch 82 in what I choose to call the "Auto" position, in which the continued operation of the sheller 10 is under the automatic control of the microphone circuit as manifested by relay 75. When foreign material of indigestible weight or size begins to move dangerously about and between the sheller elements 20 and 30 to produce noises of the loudness of *d*, indicated on the graph of Figure 3 of the accompanying drawings, the microphone 130 receives and sends an intense signal to exert bias on the grids 216 and 217 of tube 162, with the consequence of a sudden and greatly diminished current flow through coil 127 and movement of the relay contact 124 to circuit closing position, energizing solenoid 120 of relay 75 to open circuit of starter coil 56 and allowing armature of relay 52 to respond to its bias and open the high voltage circuit to the sheller motor 36.

Immediately, light 108 lights to signal that motor 36 is no longer receiving current. Where a bank of shellers are running at the same time, the signal given by light 108 is useful in alerting the operator as to which sheller has shut down. The operator, using a hook or other tool may reach into the space between the sheller elements 20 and 30 and withdraw the offending foreign matter. Then, the sheller may be restarted, as before described. However, there will normally be no need to go through the adjustment of potentiometers 165 and 172 at each starting, after a stop to remove objectionable foreign materials.

Thus, it will be seen I provide a highly effective safeguard to the operation of a corn sheller machine which may be assembled and installed at low cost and maintained with ease and but the exercise of ordinary skill.

I claim:

1. For a corn sheller of the cylinder type having a housing, a cylindrical shelling stave on the housing, a shelling cylinder rotatably supported within the shelling stave and an electric motor operatively connected to the shelling cylinder for rotating the same; a control system operative to render said electric motor inoperative to further rotate the shelling cylinder only upon the occurrence of sounds within the housing produced by the impingement against the shelling stave or cylinder of foreign materials of a mass or size that continued rotation of the shelling cylinder with such foreign materials present would likely cause damage of the shelling stave or cylinder but unresponsive to sounds within the housing produced by the impingement of foreign materials of a mass or size that continued rotation of the shelling cylinder with the latter mentioned foreign materials present would not likely cause damage to the shelling stave or cylinder, said control system comprising a movable switch electrically connected to the electric motor and operative when moved in one direction to render the electric motor inoperative; electric circuit means operatively connected to said switch for moving the same in said one direction, said electric circuit means including a microphone on said housing in sound receiving relation to the interior thereof and a part in said circuit for adjusting the signal transmitted from said microphone whereby said electric circuit means operates to move the switch only when sounds of a predetermined loudness of damaging foreign materials hitting the shelling stave or cylinder are received by the microphone.

2. In combination with a corn sheller having a housing defining a chamber adapted to receive a charge of unshelled corn for shelling; a shelling concave element supported on and within the housing in communication

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with the housing chamber; a shelling cylinder element rotatably supported on the housing and within and in spaced relation to the shelling concave element; an electric motor on the housing operatively connected to the shelling cylinder element for rotating the same at high speed relative to the shelling concave element to move the charge of unshelled corn from the housing chamber to within and through the sheller concave; and means, including an electric circuit, operatively connected to the motor and operative, on actuation, to deactivate the motor to further rotate the shelling cylinder element; a microphone in sound receiving relation with the corn sheller; connecting means operatively connecting the microphone to the motor deactivating means and operable on actuation of the microphone to actuate the motor deactivating means whereby the shelling cylinder element is no longer driven to rotate by the motor; and biasing means in operative connection with the mentioned connecting means adapted to render the microphone inoperative to actuate the motor deactivating means upon the receipt of sounds by the microphone caused by foreign materials of a mass or size that continued relative

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rotation of the elements would not through impingement of such foreign materials on the elements cause damage of either element but inadequate to render the microphone inoperative to actuate the motor deactivating means upon receipt of sounds by the microphone caused by foreign materials of a mass or size that continued relative rotation of the elements would through impingement of such foreign materials on the elements cause damage of either element.

3. In combination with a corn sheller described in claim 2 in which said biasing means comprises an electric circuit load exerting means in electrical circuit connection with the means operatively connecting the microphone and the motor deactivating means.

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