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Explosive Dusts

Code for the Prevention of Dust Explosions in the PLASTICS INDUSTRY

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NATIONAL FIRE PROTECTION ASSOCIATION
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National Fire Protection Association

International

Executive Office: 60 Batterymarch St., Boston 10, Mass.

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This pamphlet is one of a large number of publications on fire safety issued by the Association including periodicals, books, posters and other publications; a complete list is available without charge on request. All NFPA standards adopted by the Association are published in six volumes of the **National Fire Codes** which are re-issued annually and which are available on an annual subscription basis. The standards, prepared by the technical committees of the National Fire Protection Association and adopted in the annual meetings of the Association, are intended to prescribe reasonable measures for minimizing losses of life and property by fire. All interests concerned have opportunity through the Association to participate in the development of the standards and to secure impartial consideration of matters affecting them.

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Definitions

The official NFPA definitions of shall, should and approved are:

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SHOULD is intended to indicate recommendations, or that which is advised but not required.

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Plastics Industry.

NFPA No. 654—1959

This Code prepared by the Committee on Dust Explosion Hazards in 1943 and 1944, was tentatively adopted by the NFPA in 1944, and officially adopted in June 1945. Minor amendments were adopted by the NFPA in 1946 and 1959.

The Code was approved by the American Standards Association as American Standard in 1945 and reapproved as amended in 1946. A.S.A. Z12.16. The current edition is being submitted to the A.S.A. for approval.

Revision Adopted in 1959

513. New paragraph giving precautions to be followed when powder-operated tools are used.

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CODE FOR THE PREVENTION OF DUST EXPLOSIONS IN THE PLASTICS INDUSTRY.

Table of Contents.

Definitions.

In this Code the following words are used as defined below:

PLASTICS is a generic name for synthetic condensation or polymerization substances, also for certain natural substances, which under heat and pressure become plastic, and can then be shaped into a mold, extruded, or used in the formation of laminated products or molding materials. They may be thermoplastic or thermosetting.

SYNTHETIC RESINS refers to compounds obtained by the condensation and polymerization of certain substances, e.g. phenol and formaldehyde, phenol and furfural, urea and formaldehyde, glycerine and phthalic anhydride, etc.

DUST GENERATING EQUIPMENT refers to grinders, ball mills, tube mills, hammer mills, roller mills, screens, compounding rolls, bucket elevators, etc., in conjunction with which may be used dust collectors, air separators, cyclones, duct work, spouts and conveying apparatus.

PULVERIZING refers to the process of reducing or being reduced to a powder, as by grinding, crushing, or rolling in suitable equipment.

SHALL is intended to indicate requirements.

SHOULD is intended to indicate recommendations, or that which is advised but not required.

APPROVED refers to approval by the authority having jurisdiction in the enforcement of the regulations.

The terms ADEQUATELY, EFFECTIVE and SECURELY shall be interpreted as conditions subject to determination of the Inspection Department having jurisdiction.

Section I. Introduction.

101. This Code is issued as a guide to eliminate or reduce the dust explosion hazards inherent in the manufacture and handling of plastics including the handling of raw materials. This Code is intended to apply to new construction and rebuilt or remodeled plants. It is advisable to remodel wherever possible any present installations to conform with these standards. This Code also applies to certain areas of plants using large quantities of these materials.

102. While this Code is to apply to the entire plastics industry it is based largely upon experience in the phenolic resin class. Since there is a wide variation in raw materials and processing of materials in other classes, some modification of these rules in actual application would appear to be in order, depending upon the relative degree of hazard. As a guide for such modification, the materials listed in Table I are arranged in order of decreasing explosion hazard, taking into consideration the ease of ignition, lower explosive limit, as well as explosive violence.

103. The data in Table I are based on tests with dusts of minus 200-mesh fineness. Laboratory tests indicate that with increase in particle size, the ignition temperature, the minimum energy required for ignition, and the minimum explosive concentration (lower explosive limit) of the dust clouds become higher, and the maximum pressure and rates of pressure rise developed during a dust explosion are reduced. In other words, the coarser the dust, the smaller is the hazard of a dust explosion. As an example, the effect of particle size on the maximum pressure and rates of pressure rise developed in dust explosions of cellulose acetate molding powder is illustrated in Fig. 1. For this reason it is advisable to reduce the production of fines as far as practicable.

104. In some classes of materials the use of inert components in the mix such as absbestos, mica, or litharge, may reduce the dust explosion hazard.

105. It is essential that there shall be as little escape of dust as possible into the atmosphere of the plant, this condition being favorable to a dust explosion and to the rapid propagation of fire. It is important that the apparatus be provided with effective appliances to reduce the chance of iginition, relieve explosion pressure, and confine fire.

106. The equipment employed in the industry usually consists of grinders, crushers, ball mills, air pulverizers, impact and screen hammer mills, roller mills, bucket elevators, screw conveyors, pneumatic conveyors, sifters, blenders, air separators, etc. In some cases driers are used which may introduce a flammable liquid hazard in addition to the dust explosion hazard. Figure 2 shows the relation of various operations and pieces of equipment to one another in a typical molding powder process.

Section II. Plant Arrangement.

(See also Section V, "Explosion Preventive Measures," for required or recommended location and arrangement of processing equipment.)

201. Buildings in which dry material processing and handling are carried on should be detached or cut off by standard fire walls from the resin manufacturing department, storage areas, and other departments.

202. If, owing to the layout of the plant, the processes cannot be carried on in a location as recommended in Article 201, the portion of the plant devoted to them shall be segregated in such a manner as to minimize the possibility of an explosion or fire reaching other portions of the plant.

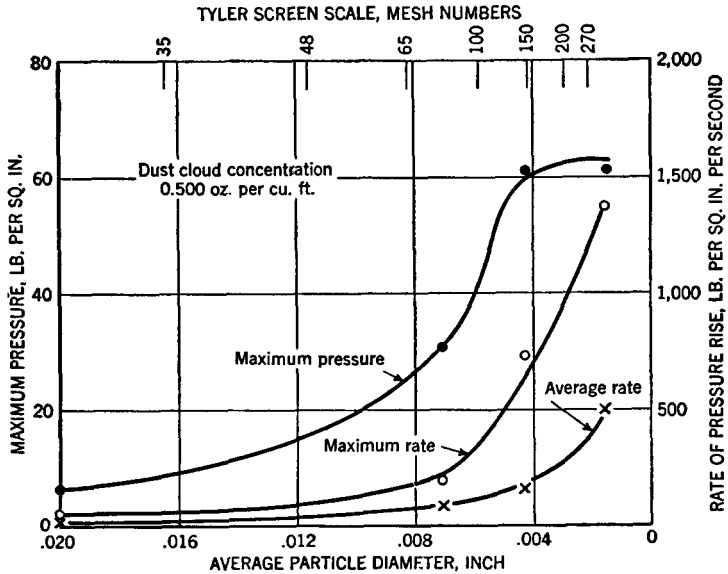

Fig. 1.—Variation of maximum explosion pressure and rate of pressure rise with fineness of cellulose acetate molding powder.

203. Departments in which finely pulverized materials are prepared and packaged for sale should, if possible, be segregated from those handling ordinary grinds.

Section III. Building Construction.

301. Buildings housing dry material handling and processing should be of fire-resistive construction, except as modified in Article 303, or of noncombustible construction.

302. To facilitate cleaning, interior surfaces should be as smooth as possible, with fillets provided at floor and wall junctions wherever practical. Window ledges, girders, beams and other horizontal projections or surfaces should have the tops sharply inclined, or other provision shall be made to minimize the deposit of dust thereon. Overhead steel I-beams or similar structural shapes shall be "boxed" with concrete or other fire resistive material.

303. Explosion venting shall be provided in a given room or space in which dry powders are processed. The venting area should approach as nearly as possible a ratio of 1 square foot to 35 cubic feet of room volume. This may be accomplished by making all or sections of exterior walls of light noncombustible material, or by the use of approved automatic pressure relief devices in the form of top-hinged windows or panels so balanced as to open outward under a predetermined pressure. Hinged windows or panels shall be fastened in such a way as to permit opening under pressure originating inside of the room. Venting areas should be located in such a manner that no part of the room shall be farther away from the venting area than a distance equal to 1.1 times the least horizontal dimension of the room.

NOTE.—The lighter the exterior wall construction, the less damage will result from an explosion, but the type employed will be influenced by considerations of cost, permanence, ease of obtaining smooth interior finish, condensation of atmospheric moisture, etc. It is necessary, however, to provide sufficient strength and anchorage to withstand possible snow and wind loads and resist the lifting force created by winds of hurricane velocity.

304. Existing buildings of combustible construction, but of a type equal in quality or better than standard mill or plank and timber construction, if used for dry material handling and processing should be protected by application to all combustible surfaces of at least one inch of gypsum plaster on expanded metal or equivalent.

305. There shall be no concealed spaces at ceilings or partitions in which dust may settle or accumulate.

Section IV. Communications.

401. Access to special fine grinding departments or buildings and dry powder departments or buildings in which there are located stock bins, blenders, weigh bins, bucket elevators, or dust arresters should be from the outside wherever possible. Doors at such openings shall open out and shall be of light construction, unless openings are seriously exposed by other buildings, in which event standard hinged Class A self-closing fire doors, opening out, shall be provided. Where direct communications from dry powder handling to non-hazardous areas are necessary, these openings should be protected by standard Class A hinged self-closing fire doors, swinging outward from the room in which the hazardous processes are conducted; when safe egress is provided to the outer air, standard automatic sliding Class A doors, normally kept shut, may be used in the communicating openings. (See Standard for the Installation of Fire Doors and Windows, NFPA No. 80.)

402. Where power is transmitted to apparatus within the processing room from any driving mechanism or unit outside of the dry powder processing department, the transmission medium (belt or chain) shall be encased inside of the dry powder processing department in practically dust-tight enclosures, constructed of substantial noncombustible material. Where power is transmitted by means of shafts, these shall pass through close-fitting shaft holes in walls or partitions. Shaft transmission of power is preferable to belt or chain drives.

403. All pipe openings through floors, wall or partitions shall be dust tight.

404. Conveyors, spouts, chutes, and elevator enclosures shall be of substantial metal construction and practically dust-tight.

405. With the exception of spouts and conveyors for raw material or for finished product in bulk, no conveyors, spouts, chutes, etc., shall pass through any of the walls or floors separating the pulverizing department from other portions of the building. Conveyors of the screw type shall be permitted to pass through the walls, provided a portion of the blade, equivalent to at least one diameter of the screw, shall be omitted at a point immediately inside of the wall of the pulverizing department and pins substituted therefor. Finished products may be delivered through the walls or floors of the pulverizing department to adjacent departments through spouts, provided the material enters the spout from bins, hoppers or other apparatus through a close fitting pocket feeder, or a screw conveyor from which a portion of the blades equivalent to at least one diameter of the screw has been omitted and pins substituted therefor, or an equally

TABLE I.
RELATIVE EXPLOSION HAZARDS OF POWDERS USED IN THE PLASTICS INDUSTRY.[1]

Type of powder[2]	Ignition temperature of dust cloud, °C	°F.	Minimum energy required for ignition, joule[3]	Minimum explosive concentration, oz./cu. ft.	Maximum pressure, lb. per sq. in.[4]	Rate of pressure rise, lb./sq. in./second[4] Average	Maximum
Hexamethylenetetramine*	410	770	0.01	0.015	64	940	2570
Shellac, rosin, gum	390	735	.01	.015	58	1240	2990
Allyl alcohol resin	500	930	.02	.035	68	1740	3560
Phenolic resins[5]	460	860	.01	.025	61	1370	3160
Coumarone-indene resins	520	970	.01	.015	63	1370	2990
Polyethylene resin[6]	450	840	.08	.025	83	410	1240
Cellulose acetate molding compounds[7]	320	610	.01	.025	62	1180	2260
Pentaerythritol*	450	840	.01	.030	65	980	2170
Cellulose acetates[7]	410	770	.015	.025	68	1370	2350
Lignin resins	450	840	.02	.040	69	760	2700
Ground cotton flock†	470	880	.025	.050	67	870	2990
Ground wood flour†	430	805	.02	.040	62	830	2080
Phenolic molding compounds	490	915	.01	.030	63	900	2080
Synthetic rubber (hard)	320	610	.03	.030	59	740	1870
Phthalic anhydride*	650	1200	.015	.015	49	1270	1690
Vinyl butyral resin	390	735	.01	.020	60	470	1020
Methyl methacrylate molding compound	440	825	.015	.020	57	570	1200
Urea molding compounds	450	840	.08	.075	63	710	1800
Pine-rosin base resin	440	825	—	.055	54	770	1740
Polystyrene-molding compound	560	1040	.04	.015	50	740	1640
Resin stabilizer	510	950	.04	.180	51	570	2000
Ground alpha pulp†	480	895	.08	.060	60	520	1450
Urea resins	470	880	.08	.070	65	340	850
Polystyrene resin	490	915	.12	.020	44	350	650
Vinyl resins[8]	550	1020	.16	.040	49	250	490
Rennet casein*	520	970	.06	.045	49	190	500
Sodium carboxymethyl cellulose	350	660	—	—	—	—	—
Vinyl molding compounds	690	1275	—	—	—	—	—
Chlorinated paraffin	840	1545	—	—	—	—	—

Asbestos, asbestine, mica.†[9] No ignitions obtained in any test; these powders present no dust explosion hazard.

[1] Table is based on tests made in dust explosion laboratory of Bureau of Mines, U. S. Department of the Interior, Pittsburgh, Pa. See Bureau of Mines Report of Investigations No. 3751, "Inflammability and Explosibility of Powders Used in the Plastic Industry," for a complete description of the investigation, including test procedure.

[2] The powders are arranged approximately in the order of decreasing dust explosion hazard. Tests were made on minus 200-mesh dusts.

[3] 1 joule = 1 watt-second = 0.00095 British thermal unit. In this test the dust clouds were ignited by static sparks from condenser discharge.

[4] Data on pressures and rates of pressure rise are for the dust concentration of 0.500 ounce per cubic foot; these are not necessarily maximum values. The values are for confined explosions in bombs only.

[5] Samples included phenol formaldehyde, phenol anhydro formaldehyde anilin, phenol furfural, chlorinated phenol, amine-modified phenol formaldehyde, and semi-resinous phenolic resins.

[6] This powder tested in minus 100-mesh fineness.
[7] Samples included cellulose acetate, cellulose acetate butyrate, ethyl cellulose, cellulose propionate, and cellulose tripropionate.
[8] Samples included polyvinyl acetate and vinyl choloride-vinyl acetate copolymers.
[9] Addition of these and other non-flammable fillers to molding compounds reduces their explosibility approximately in proportion to the total incombustible contents.
*Ingredients of synthetic resins. †Fillers for molding compounds.

effective means of producing a choke.* Material may be conveyed into or out of the pulverizing department through walls in one of the vibrating type of conveyors provided the section through the wall is enclosed in a substantial stationary metal sleeve which shall be fastened to a substantial metal hopper. The outlet of this hopper shall be provided with a choke-discharge similiar to one of the types mentioned above. (See Fig. 3.)

Material may be conveyed from the pulverizing department to other departments by means of "en masse" or drag type conveyors, provided:

(a) The conveyor housing is of substantial, dust-tight metal construction.

(b) The adjustable bearings are on the end of the conveyor located within the pulverizing department.

(c) The bearings at the discharge end of the conveyor are fastened to the conveyor housing in such a manner as to be dust-tight.

(d) The conveyor shall discharge into a dust-tight metal discharge chute or hopper, which shall be secured to the conveyor housing in a dust-tight and approved manner and the discharge of which shall consist of an approved choke-discharge.

The number and size of the openings through which any of the above conveyors pass through the walls of the pulverizing area to adjacent areas shall be held to the minimum necessary for installation and maintenance of the conveyor.

406. Air may be used to convey raw material to supply bins in the pulverizing department, and to convey finished product from the pulverizing department to another area. When used, these pneumatic conveying systems shall be fed through a rotary or pocket type feeder or an equally effective arrangement for producing a "choke" between the charging hopper and the conveying pipe. The conveying pipe shall be constructed to withstand three times the pressure shown in Table I under "Maximum pressure, Pounds per Sq. Inch" for the material to be conveyed. The receiving bin and the dust filter housing shall be substantially constructed and be dust-tight, and shall be provided with approved explosion relief vents to outside atmosphere of such size and construction as to prevent the rupture of the receiving bin and dust filter casing in

*Many different types of chokes have been developed for use with conveyors, feeding devices and other equipment. Description of chokes in this paragraph and elsewhere in this code does not imply that such devices are in all cases effective in preventing fire or explosion propagation. The selection and installation of chokes should be made in each case with technical knowledge or advice on the characteristics of the product being handled and other factors which may have a bearing on the effectiveness of certain types of chokes.

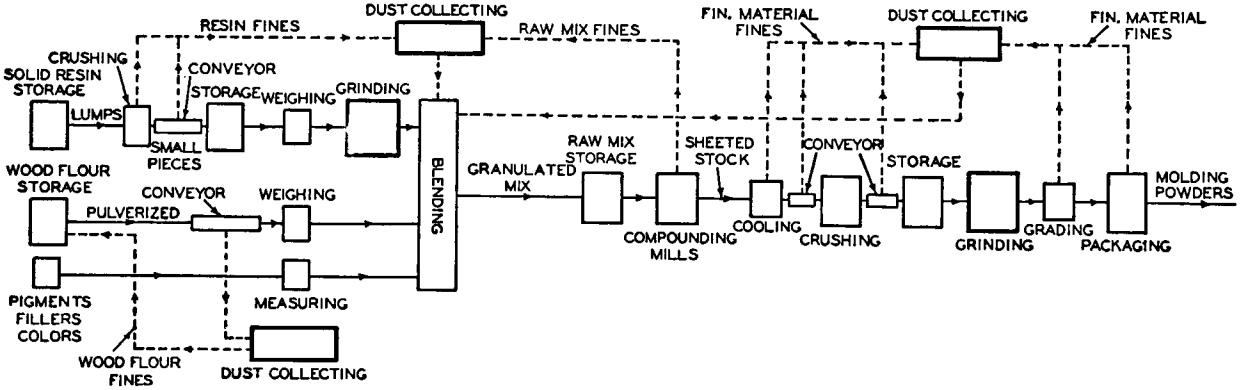

Fig. 2.—Typical flow chart illustrating a continuous process for the manufacture of phenolic molding powders.

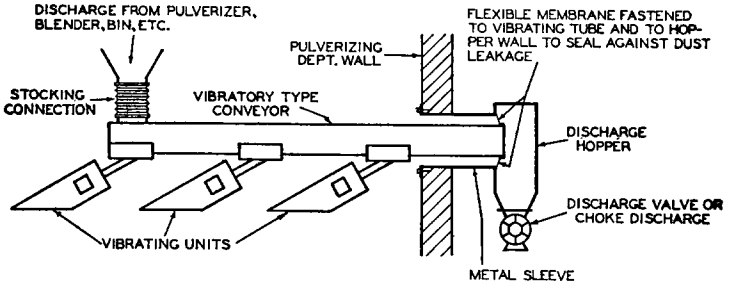

Fig. 3.—Method of conveying material through a wall by means of a vibrating conveyor, reducing to a minimum the danger of fire and explosion being transmitted from one fire area to another.

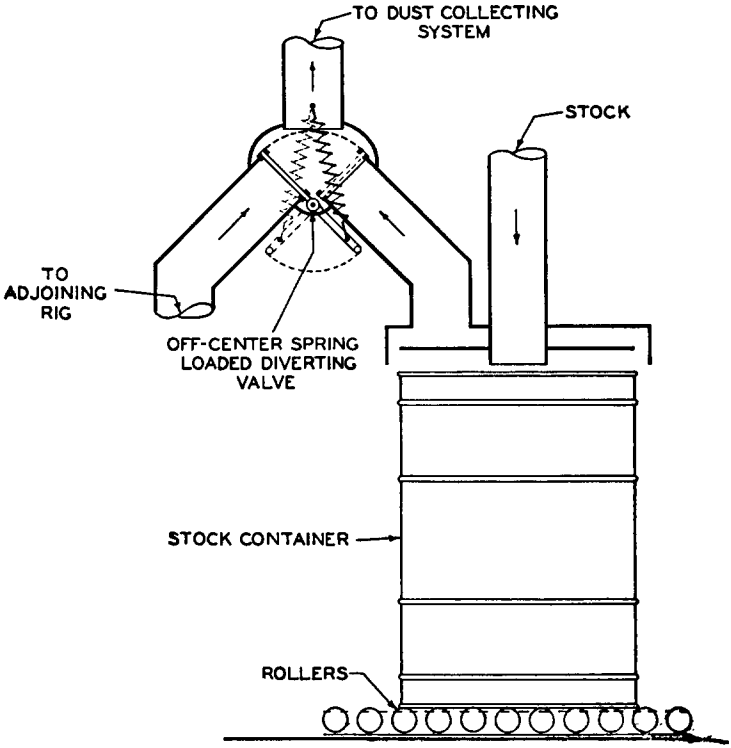

Fig. 4.—Arrangement of molding powder packaging rig, showing an efficient dust collecting hood and a special diverting or two-way valve in the dust collecting duct system.

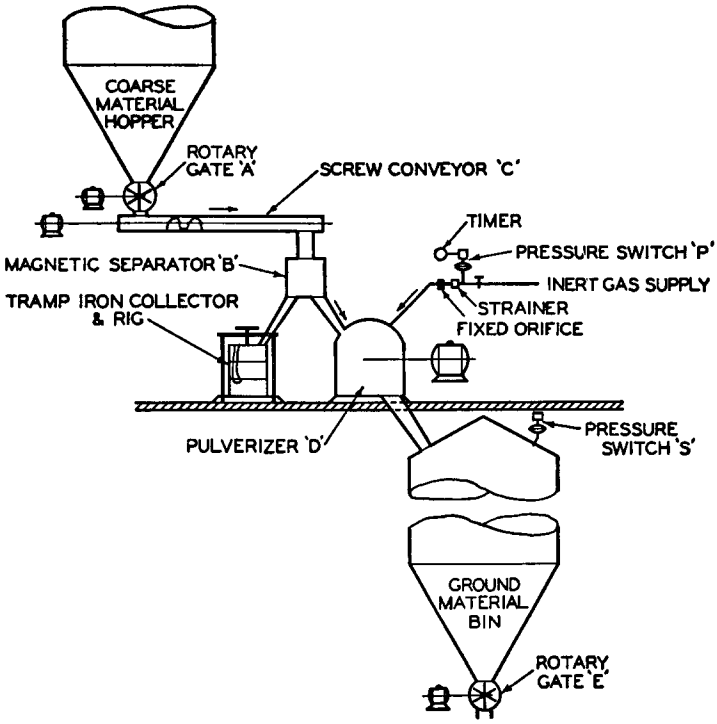

Fig. 5.—Typical grinding set-up showing principles of safeguarding. All equipment between positive locks A (or C) and E should be constructed to withstand maximum possible explosion pressure, or reduced pressure resulting from the use of explosion relief vents to atmosphere. System should be so interlocked that operation of locks or gates A (or C) and E and mill D depends upon separator B (both A.C. and D.C. circuits), and operation of pressure switch S will shut down all equipment. With inert gas protection, the starting sequence should be so arranged that gas pressure against orifice will start timer by operation of pressure switch P, unlocking separator B which in turn unlocks all other drives when predetermined safe oxygen atmosphere in grinder and bin has been reached.

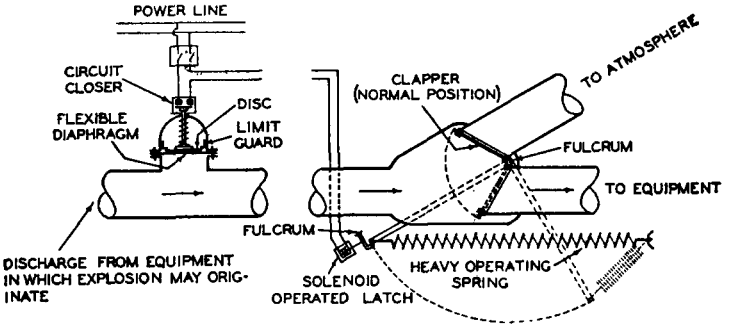

Fig. 6.—Showing arrangement of an explosion pressure pick-up device, installed close to a major piece of apparatus in which an explosion may originate, connected electrically to an automatic diverting gate, located ahead of apparatus subject to extreme damage. Such a system is known to be effective when the distance between devices is not less than 40 ft.

the event of an internal explosion of dust. These materials should not be conveyed *through* fans or blowers. (See Article 509.)

All sections of piping and all parts of the apparatus shall be grounded in an effective and approved manner in accordance with the Standards for the Installation of Blower and Exhaust Systems for Dust, Stock and Vapor Removal (NFPA No. 91).*

Section V. Explosion Preventive Measures.

501. All apparatus should be properly and securely installed to insure constant true alignment and to avoid hot bearings or friction, and no moving parts such as belts, pulleys, drive chains, etc., shall be fitted close to or come in contact with any part of the enclosures or the structure. On all grinders other than those direct driven, metal driven pulleys should be used. Bearings should be of the ball or roller type, if possible, and all bearings should be so designed as to be dust-tight. Adequate clearances should be provided around grinder shaft openings to permit flow of air from the room to the grinder interior in order to prevent the accumulation of stock and consequent heating and possible ignition. The apparatus should preferably be installed and arranged in unit systems so that each grinder will deliver only to one set of scalpers, bolters and other processing equipment of the same unit. Interconnections between (different) sets of apparatus should not be permitted.

502. All apparatus should be equipped with such devices as will:—

(a) Minimize the amount of dust escaping to the room atmosphere (see Articles 503 and 510, also Fig. 4).

(b) Reduce the chances of ignition of dust (see Articles 501, 504, 505 and 509, also Fig. 5).

(c) Localize the results of ignition (see Article 508, also Fig. 3, 5 and 6).

503. All conveyors handling dusty materials shall be fully enclosed in tight, substantial metal housings; if the tops of these housings are removable, they shall be well secured. (This should not be construed to

*See also Static Electricity, NFPA No. 77.

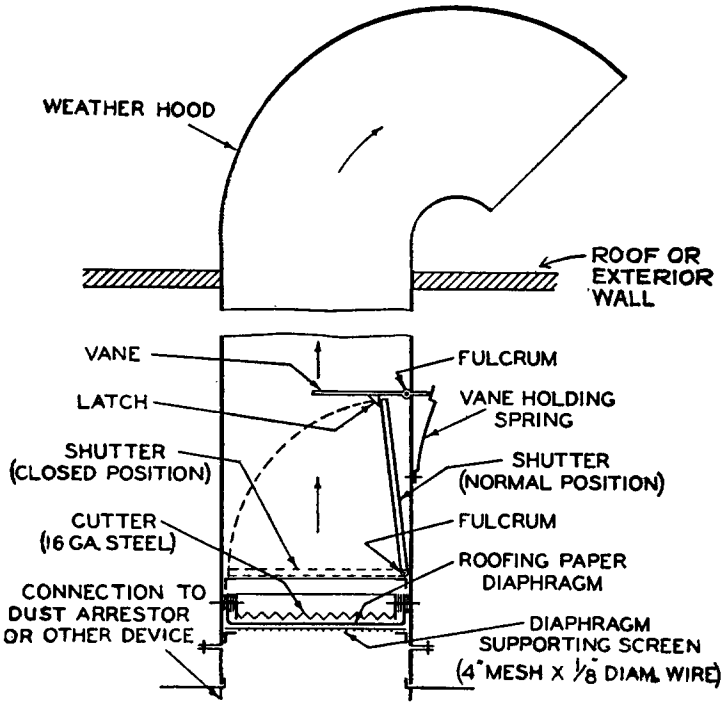

Fig. 7.—Suggested method of providing explosion pressure relief for large sheet steel enclosures such as dust collectors. The automatic shutter is provided to close the opening after the pressure has been safely relieved to atmosphere in order that efficient extinguishment of the resulting fire with CO_2 may be assured. The area of the explosion vent required is determined by the nature of the stock handled, the strength of the device to be protected, the rupturing strength of the diaphragm, the length and characteristics of the relief duct to atmosphere, etc. The diaphragm sawtooth cutter shown is readily constructed and greatly reduces the bursting pressure required.

prohibit the use of explosion relief vents.) Such conveyor housings should be so designed and constructed as to withstand possible explosion pressures, due consideration being given the effect of explosion relief vents. (See example in Appendix, also Article 702 for location.)

504. Static electricity shall be removed from all machines and equipment, including ductwork and permanently installed or portable vacuum cleaning systems and equipment, by permanent grounding and bonding wires, and from belts by grounded metal combs or other effective methods. The use of conductive belting and of low belt speeds and short center drives is highly recommended as a means of reducing the accumulation of static. Grounding connections shall be secured to equipment and to the earth in accordance with the National Electrical Code, Article 250. (See also Static Electricity, NFPA No. 77.)

505. All of the stock delivered to the mills shall pass over magnetic separators of the self-cleaning type, interlocked with the grinder drive, and the stock shall be protected against the entry of foreign materials in its passage to the mills. The separators shall be of sufficient size to expose and insure the removal of all ferrous materials passing over them.

506. If the material is dumped into the delivery hopper from a floor above the mill, such hopper opening should be provided with a protective grating to prevent the entry of foreign objects. Such openings should be provided with hoods with suction connections to a dust removal system, or other suitable means provided to prevent the escape of dust into the operating area.

507. Inspection openings in the grinding apparatus shall be provided with protective screens having openings not larger than 1/2 in. in one dimension in order to lessen the danger of injury to operators by moving parts within the apparatus.

508. Mills delivering directly through spouts should be provided with devices in or underneath the discharges which retard the flow of product in such a manner as to keep a small space immediately underneath or near the discharge filled up with the pulverized product, thus smothering any spark that may originate in the mill. This can be effected either by means of a revolving choke valve, or if material is delivered directly into a screw conveyor, by omitting a small portion of the blade and substituting pins therefor. Chutes or ducts from bins or hoppers delivering stock to apparatus in which an explosion might occur should be similarly protected.

509. Blowers or exhaust fans shall be installed on proper foundations and secured in a substantial manner. Where practicable the exhaust fan shall be located beyond the collector. When located between the collector and the grinding apparatus or any portion thereof from which the dust is to be removed, the blades and spider should be of bronze or other non-sparking metal, or (and) the casing consist of or be lined with similar material. Ample clearance shall be provided between the blades and the casing. The fan bearings shall not extend into the casings. (See Standards for the Installation of Blower and Exhaust Systems for Dust, Stock and Vapor Removal, NFPA No. 91.)

510. Screens, scalpers, bolters and similar devices shall have their reels or sieves in dust-tight enclosures. When connected to dust collectors, the

ducts shall be of metal, and the collectors shall be properly vented to the outside of the building. Care should be taken to securely ground all parts of these devices.

511. All dust collectors (except those of cloth type) shall be constructed throughout of noncombustible materials. Cloth type collectors should be provided with dust-tight metal enclosures or their equivalent. Such collector housings should be designed and constructed to withstand anticipated explosion pressures, due consideration being given the reduction in pressure afforded by adequate explosion relief vents. (See example in Appendix, also Article 701 for location.) The fabric of cloth type collectors should be electrically grounded in an effective manner. Flameproofing of fabric is desirable, wherever practical.

512. No open flames of any kind, nor any operations or repairs resulting in sparks or utilizing direct fire or heat shall be permitted in the dry powder processing department until all equipment has ceased operating and the room and equipment have been carefully cleaned (of dust), including the wiping down of equipment near the point where it is necessary to use the open flame or direct fire heat. Care shall be taken to see that the air in the room is free from dust and that first aid fire protection in the form of small hose or extinguishers is close at hand during such periods.

513. Gun-type tools using powder or cartridges for driving pegs or pins into concrete, brick, steel, etc., shall not be used where flammable dust or dust clouds are present. When the use of this type of equipment becomes necessary all dust producing machinery in the area shall be shut down, all equipment, floors and walls shall be carefully cleaned, and all dust accumulations removed. A careful check shall be made to be sure that no cartridges or charges are left on the premises where they could enter equipment or be accidentally discharged after operation of the dust producing or handling machinery is resumed.

Section VI. Electrical Equipment.

601. Electrical equipment in all rooms and spaces where dry powder is stored, handled and processed should conform to the regulations of Article 502 of the National Electrical Code.

NOTE.—Under certain conditions flammable vapors may be encountered, in which case equipment suitable for the condition should be used.

Section VII. Minimizing the Effect and Extent of Explosions In Dry Powder Processing and Handling Equipment.

701. All cyclone separators and dust collectors should be located on the roof or outside and well removed from buildings, in segregated sections of the plant, or in separate buildings or pent houses and should be provided with explosion relief vents. If this is not possible, they shall be located within the dry powder department and should be provided with explosion relief vents piped to outside atmosphere. (See Fig. 7 and Appendix 1, also Standards for the Installation of Blower and Exhaust Systems for Dust, Stock and Vapor Removal, NFPA No. 91.)

702. Bucket elevators shall be located outside buildings wherever possible and provided with adequate explosion relief vents. Where it is necessary to locate them inside, they should be located as close as possible to exterior walls to facilitate explosion relief venting (to atmosphere). (See Article 503.)

703. All dry powder stock bins of such dimensions or shape which do not permit construction of sufficient strength to resist maximum calculated explosion pressure (See Table I as a guide) should be located close to exterior walls to facilitate explosion relief venting.

704. In addition to dust arresters, separators or collectors, elevators and stock bins (as noted in Articles 701, 702 and 703), ducts, blenders, certain types of mills and spray dryers may require explosion venting. Depending upon strength and dimensions of the apparatus involved, as well as the nature and state of the stock handled, explosion relief vents may be required at intermediate points as well as terminals of such equipment as bucket elevators and screw conveyors and especially at turns in ducts (see Fig. 8).

705. Unused plugged outlets, dead-ends, or other pockets which may permit the collection of quantities of dust in ducts, pipe lines, or other conveying apparatus shall not be permitted.

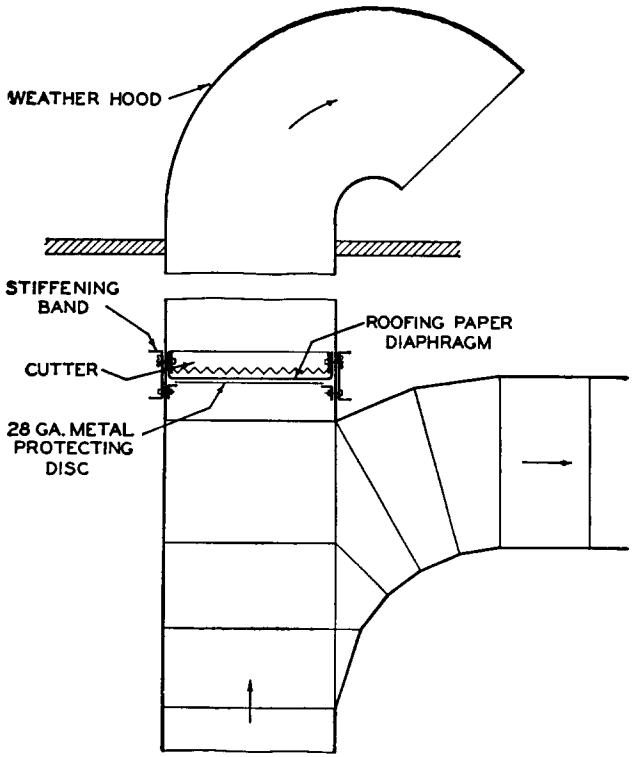

Fig. 8.—Suggested form of explosion relief vent suitable for use at duct turns. The thin metal protecting disk shown beneath the rupture diaphragm serves to prevent abrasion of the diaphragm, and upon operation of the device will blow free.

TABLE II.

PERMISSIBLE PERCENTAGE OF OXYGEN IN ATMOSPHERE TO PREVENT EXPLOSIONS OF POWDERS USED IN THE PLASTICS INDUSTRY.*

Type of Powder	Maximum permissible oxygen percentage
Allyl alcohol resin	10
Alpha pulp, ground	7
Casein, Rennet	7
Cellulose acetates	7
Cellulose acetate molding compounds	7
Cotton flock, ground	7
Coumarone-indene resins	11
Hexamethylenetetramine	11
Lignin resins	7
Methyl methacrylate molding compound	7
Pentaerythritol	7
Phenolic resins	9
Phenolic molding compounds	7
Phthalic anhydride	11
Pine-rosin base resin	5
Polyethylene resin	8
Polystyrene resin	7
Polystyrene molding compound	9
Resin stabilizer	13
Rubber, synthetic (hard)	11
Shellac, rosin, gum	9
Sodium carboxymethylcellulose	6.5
Urea resins	11
Urea molding compounds	9
Vinyl butyral resin	5
Vinyl resins	11
Vinyl molding compounds	15
Wood flour, ground	7

706. Explosion relief vents shall be of such size and design as to prevent rupture of the device or apparatus protected (see Appendix). The explosion vent ducts shall be properly designed, substantially constructed of metal and be carried out-of-doors as directly as possible, avoiding sharp turns—never through an adjoining building or room.

707. Explosion relief vents should be fitted with cowls or hoods, and where the non-escape of dust is essential, with rupture diaphragms, preferably fitted with cutters to accelerate rupture. See Figs. 7 and 8 for details of suggested diaphragm and cutter construction.

708. The use of inert gas is urged to create safe atmospheres within mills and other apparatus, where practical, especially those handling exceedingly fine stock. (See Standard for Inerting for Fire and Explosion Prevention, National Fire Codes, Vol. II NFPA No. 69, also Fig. 5.)

*These results are based on tests with ignition by hot surfaces when carbon dioxide is used to reduce the oxygen percentage in the atmosphere. The maximum permissible oxygen percentage may be somewhat lower if nitrogen is used as the diluent instead of carbon dioxide. For data on spark ignition and for a description of test method and other details, see Bureau of Mines Report of Investigation No. 3751, "Inflammability and Explosibility of Powders Used in the Plastic Industry."

The approximate safe oxygen percentage in atmospheres for various stocks involved in the industry is shown in Table II. If ample means is provided for maintaining an inert atmosphere in bins and equipment the explosion venting requirements of this section may be modified.

Section VIII. Housekeeping.

801 (a). Good housekeeping is an extremely important factor; apparatus which will not leak and permit the escape of dust or sifting out of the material is essential. Accumulations of dust shall not be tolerated in the building. Particular attention should be paid to horizontal surfaces such as ducts, pipes, hoods, etc., on which quantities of dust may accumulate. It is recommended that the interior of the dry powder processing department be painted a color which is in contrast to that of the dust.

(b) Interior surfaces shall be cleaned in such a manner as to minimize the scattering of dust to other places. To this end it is recommended that dust-removal be accomplished by an adequate pneumatic or vacuum-sweeping system.

(c) Cleaning that is liable to result in production of dust clouds shall not be done while machinery is in operation because of the possibility of the dust being ignited.

802. (a) Portable vacuum cleaners, if of a type approved for hazardous locations, or fixed pipe suction systems with remotely located exhauster and collector, may be used for cleaning. Suction-cleaning appliances should be connected by hose to taps of permanent piping extending to a suction fan or equivalent. Care should be exercised in the grounding of all hose outlets.

(b) The exhauster and the collector shall be located outside the dry powder processing department.

(c) Permanently piped dust collecting systems for cleaning purposes should be independent of all other dust collecting systems.

Section IX. Fire Extinguishing Systems.

901. The buildings or rooms in which the storage, processing, and handling of dry powders are conducted shall be protected by a system of approved automatic sprinklers and shall be equipped with approved first aid fire appliances, together with approved small hose. (See Standard for Sprinkler Systems, NFPA No. 13; Standpipe and Hose Systems, NFPA No. 14 and Portable Fire Extinguishers, NFPA No. 10, all published in National Fire Codes, Vol. IV.)

902. Apparatus of large volume in which pulverized stock is stored or may accumulate, such as bins, silos, dust collectors, etc., shall be protected by:

(a) Automatic sprinklers or fixed pipe inert gas extinguishing systems, or both. It is important that means be provided to automatically close all openings to the enclosure involved, including rupture diaphragm vent openings, also to shut down all blowers in connection therewith in order to confine the extinguishing agent and prevent the spread of fire.

(b) Properly located small hand hose connections, with adequate hose and nozzles or water-spray applicators, for use in manually extinguishing smoldering stock fires.

(See Article 704, also Standard for Inerting for Fire and Explosion Prevention, NFPA No. 69; also Technical Bulletin No. 74, U. S. Dept. of Agriculture; also Fig. 7.)