DISCUSSION OF PAPERS PRESENTED AT THE THIRD SESSION

Mr. J. C. Mecklenburgh said that Simmonds and Cubbage advocated relief at the side of the oven. Derbyshire had put relief at the top on the roof, and Matheson, in presenting his paper, had advocated both methods. Had Simmonds and Cubbage done any work to show which was the best, top or back, or, would they advocate both?

Dr. Simmonds replied that work had been done on both top and back reliefs, both of which worked in a very similar way and when properly designed were equally effective. Back-reliefs were preferred for box ovens because of the weight of the top relief and the difficulties of siting a top relief in a box oven.

The top relief had not only to be pushed out of the retaining framework in an exactly similar fashion to the back relief, but it also had to be removed clear of the vent and its own weight opposed that movement. With a back relief gravity assisted the movement and thus a more rapid opening could be achieved. From the practical viewpoint the presence of flues, dampers, damper controls, and fan motors on the top of box ovens split the available area for the relief into a number of small sections and a large proportion of the remainder could be taken up by supports. Another reason for advocating the use of back reliefs was that in the majority of box ovens the work was supported on shelves so that a top relief could be effectively screened from an explosion.

If the work consisted of large sheets that were hung vertically in the oven then, of course, a relief fitted in the top was to be preferred ; but that was relatively infrequent and in general back reliefs were advocated.

Dr. F. Sjenitzer asked whether a ducted system where there was atmospheric pressure and where vents operated at $\frac{1}{3}$ lb/in²g, could also be used for gases at a pressure of 2–3 atm abs.

Dr. Rasbash said that all the experiments had been made with the contents of the duct at atmospheric pressure. Although it would be expected that the same principles would apply at pressures other than atmospheric, it would become progressively more difficult to put the principles into practice as the pressure inside the duct deviated more from the pressure outside the duct. The values $\frac{1}{3}$ lb/in² was a figure to aim at, but good results would be expected if the vent was released at pressure of $\frac{1}{2}$ or 1 lb/in² above the pressure in the duct. The difficulty with ducts containing gas at a relatively high pressure—say 30 lb/in²g—would be that even if the vents were arranged to be opened at a slightly higher pressure—say 32 lb/in²—only the first vent would open efficiently if there was a long series of vents in a duct system. After the first vent had opened the pressure inside the duct might drop rapidly and the differential pressure between the opening of subsequent vents and the pressure inside the duct would be greater than the initial 2 lb/in². It was feasible to divide a large duct system into such units by the use of flame arresters. Alternatively, a series of relief vents could be made to open automatically, or the relief vents could be opened by melting on contact with the flame. Thus if polythene were supported on the inside of a wire mesh structure, the pressure which the duct would take before bursting would depend on the closeness of the mesh, but as long as the mesh was not too close it should not interfere with the melting of the polythene.

Dr. Sjenitzer said that his question was more concerned with the practical side. If the pressure was 2–3 atm the vents had to be clamped at an excess pressure of more than $\frac{1}{2}$ atm and would become loose at a differential of only $\frac{1}{3}$: that seemed to be difficult to arrange.

There were much stronger modern magnets than those shown in Fig. 2 of the paper by Rasbash and Rogowski wherein there were eight magnets which had to give a total force of 20 lb. There were magnets which were at least 10 times as powerful.

Dr. Rasbash said that there was scope for increasing the differential at which the vents operated. The main thing was to keep the flame speeds down and that was particularly important if ignition took place in the vicinity of obstacles. The pressure differential employed was not limited by the availability of magnets and the usefulness of magnets and similar types of device was that there was little resisting force once the pressure at which the vent began to open was attained.

Mr. J. R. C. Congdon said that in connection with the magnetically held covers Rasbash and Rogowski mentioned a weight of 50g/ft² for the light covers. Could they give a figure for the others?

Dr. Rasbash said that the weights of the covers for both were about 250g/ft². The covers held by magnets were clamped to the duct with a force of 20 lb/ft², but the weight of the cover was approximately the same as that of the light cover resting on the duct.

Mr. R. H. B. Forster said that the application of a polythene duct appeared very attractive but it would be vulnerable to external damage and also might be dangerous to personnel. He enquired whether consideration had been given to the use of a mild steel shield at some distance from the polythene. It would need careful design in order that the venting properties should not be nullified.

Dr. Rasbash said that it would certainly be desirable to have some outside duct to contain the flame as well as to prevent damage to the polythene. They had thought more on the lines of having a gauze duct outside the polythene duct to act as a flame arrester. The danger of having a closed duct outside the polythene duct was that if there were a leak in the polythene, the duct might become filled with flammable vapour. Also a safe explosion in the polythene duct might give rise to a build-up of unburned gas in the protecting duct, which would be followed by a violent explosion.

If the contents of a duct were at approximately atmospheric pressure, the protecting gauze need not be exceedingly fine. Although flame would be ejected in large quantities from the polythene duct in the event of an explosion, the outward velocity would be relatively small and it would be easy to quench. The same consideration might not apply if the contents of the duct were at a high pressure since the bursting of the duct would be followed by a rapid ejection of gas and flame.

Mr. C. A. Cross said he was concerned about what seemed to him to be a slight difference of opinion between the papers by Rasbash and Rogowski and the paper by Simmonds and Cubbage. The first paper advocated the provision of a relief which occupied the whole of the back area of the oven ; when discussing the extrapolation to long ovens, the authors implied that it would be necessary to make the whole of one side of the long oven into a pressure relief. Comparing that with the second paper, on explosions in ducts, quite small relief areas at intervals of several duct diameters were advocated. Was that a discrepancy in the results of the papers or was it due to a difference in the strength that was assumed for the structure?

Dr. Simmonds said one answer was that the sizes of the plants were rather different. The scale considered in the paper by Simmonds and Cubbage was that of the conveyor oven which could have a cross-section of 8–10 ft^2 : that was rather large to be considered as a duct. Rasbash and Rogowski had not experimented with ducts of sizes approaching 8 ft^2 cross-section.

Mr. Cross said that Figs 6 and 8 of the paper by Rasbash and Rogowski indicated that there was a difference in the actual experimental results which might be due to scale effects. In the paper by Simmonds and Cubbage the maximum pressure of 7 lb/in^2 was being developed, with one-quarter the area of vent, whereas in the former paper a pressure of 6 or 7 lb/in^2 was developed.

Dr. Rasbash said that part of the explanation was that the experiment of Simmonds and Cubbage was carried out with town gas and that of Rasbash and Rogowski with propane/air mixtures. There was some evidence that one might be able to extrapolate from a small duct to a large duct. The point was that when the gas was ignited in the middle of the air duct, there were already two vents equal to the cross-section of the duct. The idea of providing vents along the duct was that that system could be maintained. It was an odd way of considering it, perhaps, but the system was different from a cube system. On the other hand, with a duct, there was the opportunity for the flame to accelerate and the combustion rate to be increased if the combustion products were not relieved. With such conditions, a larger venting area was needed. Putting the vents along the duct stopped that happening and allowed the venting present to relieve the gases more efficiently.

Further evidence was also provided by the results of Simmonds and Cubbage with vessels of dimensions $3 \times 2 \times 1$ which indicated that the same correlation employing the K factor could be used both for that vessel and a cube. With the end of the vessel used as a vent, a maximum pressure was obtained which was similar to that obtained when one side of a cube was used as a vent.

Dr. Simmonds said that they had obtained experimentally a difference of about 4 in. pressure between methane/air and town gas/air explosions. Propane has a slightly higher flame speed than methane and thus a difference of a factor of 3 between the pressure generated by propane/air and town gas/air mixtures would be expected.

The explosion pressure increased with temperature of the unburnt mixture and with vapours approaches something very similar to that obtained with cold town gas/air mixtures. Town gas, which was therefore a convenient substitute, was used throughout the experiments.

Mr. R. H. Beresford said that, in the equation presented by Rasbash and Rogowski involving K, one would have to divide by some pressure factor to reduce it to a dimensionless form. Was there any evidence to show that it was related to either the weight per square inch of the cover or to the absolute pressure of the gas? That equation gave a pressure inversely proportional to size of the opening. In the paper it was said that the pressure rise was inversely proportional to the 0·4 power of the size of the opening for supplementary vents. Had the authors any special comments on that?

Dr. Rasbash said that the equation referred to could be made dimensionless by dividing the maximum pressure by the absolute initial pressure in the duct. However, there was not sufficient evidence to say that the equation could then be used for initial pressures other than atmospheric. The weight of the cover could not legitimately be brought into the equation since the results referred to an open vent.

The provision of the supplementary vent gave rise to a substantial alteration in the geometrical disposition of the total venting, extra relief being provided for an explosion which was already relieved by the open end of the duct. In any case over most of the conditions studied, equations (1) and (2) did not apply for K factors less than 2. In the experiments where a supplementary vent was used, the K factor, if it could be estimated at all, was less than 1, though perhaps the K factor ceased to be meaningful under these conditions.

Mr. Beresford said there was no factor of 0·8 except for the supplementary vent. Regarding the size of the vent, Mr. Beresford asked whether the measurement referred to was linear or that of an area.

Dr. Rasbash said that the exponent of 0·4 applied to one supplementary vent at a given distance from the ignition source. The size referred to was the area of the vent.

Mr. A. J. Carter said that he was concerned with protection of ducts which operated above atmospheric pressure. Even if the pressure was only 2 lb/in^2 it was difficult to arrange a vent which would not lift at 2 lb/in^2 but would lift at 2·3 lb/in^2. One required something which would lift when a given rate of change of pressure was exceeded rather than when a given pressure was exceeded. There were such devices but one baulked at the electrical equipment which went between the sensing element and the vent or explosion suppressing devices.

Dr. Rasbash said that he was not entirely happy with the principle of a relief vent operated by the rate of change of pressure (dp/dt). As indicated by Figs 7 and 10 in his paper, dp/dt could be very small while a flame travelled towards an obstacle in a duct. Downstream from the obstacle there might be a sudden rise in pressure such that even with a vent open quite near by a substantial pressure rise was obtained. The records referred to indicated that if that method were used the detector should operate at a value less than 5–10 lb/in²s within a time of about 1/50–1/20s. He fully realised the difficulty of using the small pressure differential. The only answer was to aim for the smallest practicable differential, though for complete safety there would be an upper limit to the differential which would depend upon the system. Thus examination of Figs 7 and 10 indicated that if it were desired to vent that particular system, the vent would have had to be operated at a differential less than 1–1½ lb/in² since that was the maximum pressure prior to the flame reaching the obstacle in the duct.

Mr. V. Kenworthy said that, as a plant designer, he was concerned with what happened to the relief covers that were removed and secondly, with what was done with the vented products. Ducts were designed in the drawing office to contain noxious vapour, but when an emergency arose another device was needed to deal with the products of explosion. How much must the relief mechanism of ovens be displaced to give the safe pressure relief rate, and how did one accommodate the displaced cover without introducing other hazards? Furthermore, how did one deal with the explosion products released through a large explosion vent inside a plant building?

Dr. Simmonds said that the removal of the relief depended on the spacing of the oven from a wall or any other obstacle behind it. Obviously, another piece of plant near the oven was equivalent to a wall. The spacing was the distance to which the relief must be allowed to be projected in order to give sufficient clearance. If the relief were moved only partly out of the way there would be a restriction and a higher pressure generated inside the oven.

In industrial practice, combustion products were not very noxious. They might not be beneficial, but as most of the vapours in the oven would be burnt a highly dangeıous atmosphere would not be left. In any case the volume of products released (measured at room temperature) would be relatively small compared with the size of the room in which the oven was installed and thus dilution by the surrounding air would mitigate the problem. The problem would exist, of course, when the vapour being dealt with was a particular hazard itself.

Dr. Rasbash said that the danger that flammable gases and hot combustion products could pour out of a duct system with gases flowing along almost without restriction did give rise to practical objections to the use of relief vents. In theory, one wanted to have everything open to keep the pressure down inside the duct and to keep the flame speed in the duct as low as possible. As far as not allowing more than the absolute minimum of flammable vapours and combustion products to get into the atmosphere was concerned, it might be desirable, after opening, to shut the vents again. It was possible to design relief vents to do that. There were a number of ways in which a vent could open at a very small pressure and, after a while drop back by gravity or springs. It was only when hot combustion products were being pushed out of the duct that the vent was open. It was most important that there should be relief vents in the neighbourhood of the flame—in particular just behind the flame—through which the hot combustion products would leave. It was also important to provide each relief vent with a flame arrester or a gauze, which would at least remove some of the heat in the combustion products and prevent ignition of other things in the vicinity.

Dr. Cohen asked if it was possible to express the flame-quenching ability of the various types of devices discussed in terms of pressure drop. Was it possible to say which was the most efficient in terms of pressure loss, as that was an important factor in design? Taking two very different types of arrester, the packed column and the sintered metal arrester, Dr. Cohen asked if there was any advantage of one over the other in that respect?

Mr. Palmer said that he had not examined the problem but in general there was probably a correlation between pressure drop and quenching ability, as specified by the maximum velocity of flame just quenched by the arrester. The correlation would probably apply to arresters containing smooth-walled passages but might not apply, for instance, to randomly-packed gauzes. For ordinary working, the flow would be streamlined and the pressure drop would vary with the diameter of the aperture, d, and the length of the passage, y, possibly depending on y/d^2. However, it was essential that the diameter of the aperture should not exceed the critical quenching diameter, otherwise the arrester would fail no matter how thick it was. An arrester could be designed to give a certain pressure drop at a certain flow-rate by making it very thick and with passages of large diameter. But such arrester would not quench flames. With a packed-tower arrester the passages through the arrester varied in width and it was essential that none was sufficiently wide to allow flame to pass. Measurements of pressure drop would give only an average value.

A convenient method of causing a substantial reduction in pressure drop was to enlarge the duct where the arrester was installed. The widening of the duct reduced the velocity of the gas passing through the arrester and so reduced pressure loss.

Mr. A. V. Bailey asked if there was any simple relationship between the flame-quenching performance of arresters and the heat to be removed per unit volume of either the combustible mixture or the products after combustion.

He was thinking particularly of the prediction of the performance of arresters with combustible mixtures containing hydrogen from results obtained with hydrogen alone.

Mr. Palmer said that in burning stoichiometric mixtures of a wide range of hydrocarbons and similar compounds in air the total amount of heat released did not vary much. In fact, it was necessary to extract about one-quarter of the heat released in the flame front in order to quench the flame (including hydrogen flames). It might not be the case for detonations in hydrogen and in other fields.

Mr. H. H. Meyer said that Palmer had stated that the effect of his type of flame arrester was largely due to heat transfer. A certain amount of heat was generated in the volume taken up by the arrester and passed into the tube. One might expect that as the tube size increased the amount of tube wall per unit volume available for dissipating the heat was considerably reduced. What was the diameter of flame arrester Palmer had used, and what was the limitation in pipe diameter for which these particular devices—wire mesh screen or perforated metals—could be used?

Mr. PALMER said that in the experiments he described the tubing was 2½ in. internal diameter and it was not expanded at the arrester. If the size of tube were increased, and the diameter of the arrester was increased in proportion, the surface area of the walls of passages through the arrester would also increase in the same proportion. There would thus be the same area of passage wall per unit volume of flame. The amount of heat transferred to the arrester in quenching a flash of flame was so small that it raised the temperature of the arrester only a few degrees.

Some further experiments had been done with a duct of one foot diameter and the effectiveness of the perforated plate arresters was not markedly different. The work was still in progress. With the larger diameters, mechanical failure of the arresters became a problem. Wire gauzes and thin perforated metals were flimsy and tended to disrupt or bend. By using external bracing, with more robust arresters, the problem could often be overcome by simple mechanical means.

Mr. E. WOOLLATT asked if he was correct in thinking that, in order to apply the result reported by Palmer, one had to decide with what velocity the flame was likely to arrive at the arrester. That would depend upon the distance from the point of ignition and the various other factors.

Mr. PALMER said that that was so, and it was one of the difficulties. The main intention had been to compare the different types of arrester and determine what type of flame they would withstand. There was also the problem of the type of flames in the practical system. Attention should be paid also to the provision of vents because if venting was provided to keep flame speeds down, the arrester could be relatively coarse. If it did not have to withstand flames having speeds of hundreds of feet per second, the provision of an arrester was much easier. One would look askance at any system where one had 20, 30, or 40 ft of pipe which could contain a flammable fuel/air mixture with no protection in it at all. If such a system were installed a very effective arrester would be required. Those described in his paper would not be sufficient, but they would be practicable, and have quite an economic attraction if vents could be provided to keep flame speeds down so that the arrester itself was never exposed to a very fast flame.

Mr. D. M. ELLIOTT said that he was using combined explosion boxes and flame arresters filled with 1 in. Raschig rings. From Palmer's results it appeared that no exact criteria could be applied to the design of such arresters, since the random nature of the packing made it a matter of pure chance whether sufficient passages would be obtained of the very small diameter required to quench the flame. In the paper by Rasbash and Rogowski it had been noted that obstructions to flow tended to increase the explosion effect downstream of the obstruction, and in that way a random packed bed might perhaps have the opposite effect to that desired.

Could Palmer comment on the effectiveness of that type of arrester, and in particular had he any experience with these or the perforated plate type handling gases liable to detonate such as hydrogen or acetylene?

Mr. PALMER said he had not worked on acetylene.

Raschig rings would be effective provided that they were sufficiently small and there were enough of them to prevent excessively wide continuous channels through the bed. For instance, with propane/air mixtures, a channel ⅛ in. wide or more would permit a flame to propagate slowly through the layer. However, the whole subject needed detailed investigation. Problems of how thick to make the layer of rings, the size of the rings and their arrangement, and the types of explosion that would be arrested all required systematic study.

The increased explosion effect downstream of an obstruction, as noted by Rasbash and Rogowski, would occur if turbulence were generated. But with packed towers the flow through the bed would often be streamlined, so that a serious increase in explosion violence would not be expected.

Dr. J. H. BURGOYNE said that, in his view, an important point had been brought out when attention was drawn to the fact that the performance of the flame arrester depended on the rate of flame propagation but that there would be lack of knowledge of that in a particular case. There was a possible answer which was that there was a limiting value to the rate of flame propagation after travel over long distances which might in some cases be the detonation velocity, or might, in others, fall short of that value. It was possible, as Simmonds and Cubbage had shown, to cope with the limiting speeds of explosion with arresters of the crimped ribbon type.

Dr. SIMMONDS said that the object of the work was limited to flame traps for use with town gas/air mixtures. That was to say, a situation where one deliberately made a pre-mix. They assumed that if they could show that an arrester or flame trap existed which was not intolerable on grounds of pressure drop or anything else, and would stop detonation, that it was the answer to all the problems because one could obviously use it and the pressure drop would not be prohibitive.

They had been able to get a solution to that situation, using a crimped ribbon arrester in a special form of housing. The object of it was that there was a deceleration of a flame when it reached a sudden enlargement. Using that system, they had data which enabled flame traps to be designed for pipelines up to 4 in. diameter and, by extrapolation, up to 8 in. Crimped ribbon arresters were, of course, commercially available. The housings were not yet available but were not difficult to make.

They had had their special field of gas/air premix to consider, but since they were considering detonation, and since gas/air detonation velocities were very similar, the system could obviously be applied to other fuel/air mixtures. The arresters and traps did stop detonation; the dynamic pressure on the trap was of the order of 20 atm when detonations reached it and it did withstand them. That meant that they could be used under quite high pressure situations on an outlet to a tank.

With regard to plastic arresters: in the course of the work they had used arresters (they might be called crimped ribbon arresters) made of gummed brown paper about 1 in. wide as used for wrapping parcels. If that paper was moistened and fed into a crimping machine an arrester could be fabricated which would stop detonations as well. It only lasted for two or three detonations because the leading edges of the paper became distorted. There was no great practical significance in it except it did emphasise the point that the material actually usea had no great significance.

Dr. L. L. KATAN referred to Palmer's statement that only one-quarter of the heat of the flame had to be removed. Did that not suggest that the mechanism was not quite so simple as mere heat removal, and that possibly the true mechanism in many cases was the interruption of free radical and, perhaps, energy chains?

Mr. PALMER said that that was a question that frequently occurred throughout the field of flame propagation: to what extent propagation was the result of conduction of heat into unburnt gas and to what extent it was the result of diffusion of active particles ahead of the flame front. Both processes obeyed the same mathematical laws, so they could not be separated by writing down a few equations to see which described the effects. One point which put him in favour of a heat transfer mechanism for flame arresters was that the nature of the surface to which the flame was exposed when it was quenched did not matter. In particular, metals coated with substances like potassium chloride, which were known from work on reaction kinetics to be effective chain breakers, did not acquire enhanced flame arresting properties. Determinations have been reported of the quenching diameters of different gas mixtures in tubes coated with various materials, including reaction chain breakers, but no effect was detected. The suggestion was then made that all surfaces were 100% effective in terminating chain reactions. The fact that that suggestion was necessary tended to count against the theory, but did not disprove it.

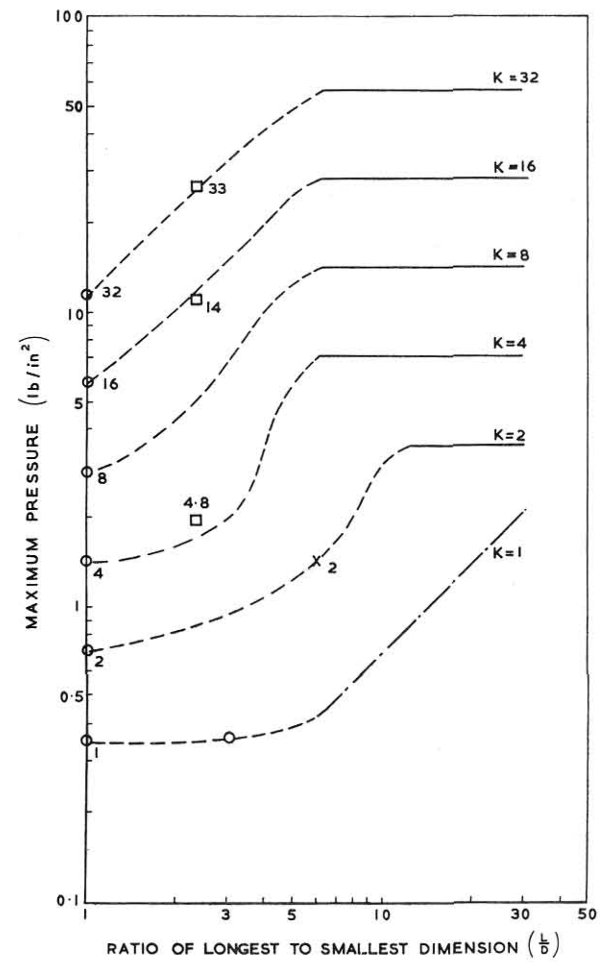
Mr. D. BRADLEY said he believed that in the absence of over-riding considerations it was common practice to site flame arresters in the coldest part of the system. Could Palmer comment on that in view of the fact that heat transfer was not a controlling factor?

Mr. PALMER replied that, so far as he knew, there was no general recommendation that the flame arrester should always be put in the coolest part of the system. The temperature difference between the flame and the surface was about 1800°C. If the flame arrester was at 100°C instead of, say, 20°C the temperature difference between it and the flame had only changed by 5%. However, the rate of burning of gas mixtures varied with the initial gas temperature more markedly, and so a flame would propagate more rapidly through hot combustible mixtures than through cold mixtures. As the flame speed at the arrester should be as low as possible, there was something in favour of installing the arrester in cool gas, provided that blockage due to condensation of volatiles would not be a nuisance.

Dr. SIMMONDS said that a flame trap should be sited as near as possible to the probable point of ignition.

Dr. M. J. G. WILSON said he had tried to compare the results of the three papers on explosion relief in terms of the relation between the maximum explosion pressure expressed in pounds per square inch gauge and the ratio of the vessel cross-sectional area to the vent area, K. Simmonds and Cubbage, with coal gas in roughly cubical enclosures, found that P was about equal to K. Rasbash and Rogowski, with propane or pentane in long narrow ducts, found $P = 0{\cdot}8$ to $1{\cdot}8\,K$. Burgoyne and Wilson, in the second session, with pentane in short cylinders, reported $P = 1$ to $1{\cdot}5\,K$ for undisturbed explosions and $P = 3$ to $4{\cdot}5\,K$ for violent explosions with rich mixtures.

Dr. RASBASH said that they had attempted a correlation of the type described and broadly they had found that they could correlate results fairly well, except for the results of Burgoyne and Wilson for small vents (*i.e.* vents with a large K factor) in a large vessel of $L/D = 1$, approximately. The correlation obtained is shown in Fig. 1 in which the maximum pressure was plotted against the ratio of the maximum to the minimum dimension of the vessel for different K factors.



PROPANE—AIR MIXTURE

O = Based on the work of Simmonds and Cubbage

X = Point obtained at J.F.R.O. for $K = 2$ with a 6 ft duct o 1 ft square section

□ = Cousins and Cotton. Volume of vessel = 3.0 ft²

——— = Equation (2) of paper by Rasbash and Rogowski

— · — = Equation (3) of paper by Rasbash and Rogowski

The numbers refer to the values of K

Fig. 1.—*Relation between maximum pressure and length to diameter ratio for different vent ratios*

The correlation was based on the work of Simmonds, Cousins, and Cotton and the authors. It would be noted that there was a general tendency for the maximum pressure to increase for a given value of K between 2 and 32. The reason for the increase in pressure was that turbulent flow was becoming established along the duct which increased the rate of combustion and the flame speed; the reason for the constant pressure was that the flow had become established and the flame speed was approximately constant. However, even for values of K between 2 and 32, it had been found at Fire Research Station that the maximum pressure rises again for values of L/D in excess of 30. The reason for that increase was not clear, but it had been observed that explosions taking place under those conditions were accompanied by intense vibrations which might have brought about a further increase in the rate of combustion. Results of Burgoyne and Wilson showed maximum pressures which were higher than given by the correlation, although there was some evidence that they tended to extrapolate towards the correlation for low values of K. As indicated by those authors, the reason for that difference might be the distortion of the flame caused by disturbances in the unburned gas flowing through the vent. On the other hand, the results of Swedish work[1] indicated that correlation might be applied with only a small error for a large vent in a vessel of very large volume (7000 ft^3) with values of L/D and K approximately unity.

Mr. E. C. B. Bott said that it was difficult to find out if one had allowed for all possible hazards, particularly with new organic chemicals. Was there any printed procedure that would tell people how to go about the job in a better way than just working off their own bat? Often, ducts contained small amounts of solids, such as dust, in suspension. Polythene ducts and mild steel ducts had been mentioned. Some organic substances produced electrostatic properties. Could Rasbash say something about the differences between these organic polymers and steel regarding their electrostatic properties?

Dr. Rasbash said that the Joint Fire Research Organization was always very pleased to answer people's queries specifically. Queries from industry were welcomed. The Factory Inspectorate was also very active in this field.

The Joint Fire Research Organisation had not done any work on the development of static charges in dust. A considerable amount of work had been done in Germany on the development of static charges in dusts flowing through ducts. If the nature of the dust and the tube were approximately the same, there was not as much charge formed as if they were quite different. Work had been done at the Bundesanstalt für Materialprofung in Berlin.

The use of polythene was suggested as a way it might be done; there were other ways of building a duct so that it would disintegrate safely, or explode safely when a flame passed through it, and which would prevent the flame increasing in speed. Polythene might not be good for duct carrying because the dust might abrade the polythene in a short time. A very light duct which was hard and which would fly open in a controlled manner might be a possible answer.

Reference

1 *Report of Kommitten für Explosions Forsok*, 1957. (Stockholm: Kommitten für Explosions Forsok.)