AVAILABLE PIPE CONNECTORS VERSUS THEIR GEOMETRICAL CORRECTNESS

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Abstract. The paper discusses different constructional solutions of pipe connectors, indicating various level of background of designers who have designed them. Construction of connectors made of plate (ruled surface) and plastics have been presented.

Keywords: pipe connectors, constructing, scrolled/ruled surfaces, expansion

The paper is dedicated to the memory of Professor Marian Palej (1923-2001) in his 90th birthday anniversary.

1 Introduction

Production of many elements of both chimney installations and sanitary ones is conducted in Poland in vast majority by small companies. According to survey carried in June/July 2013 in Poland, out of 11 companies which produce chimney elements one is a joint stock company listed on the Warsaw Stock Exchange, 6 are limited liabilities companies, and 4 are small businesses. Such small companies usually have limited number of machines, they do not have design or research departments and thus, products are adapted to production possibilities of a given company. Competition makes the companies use cheap solutions in production.
Awareness of obvious parameters and design features for experienced manufacturers is verified according to market demand, which promotes choice by price parameter and not necessarily of product features.

2 The components made of sheet metal (developables)

Features of geometric elements made of steel, which will not be pressed, must meet the conditions required for scrolled elements. Hence, the proposed shapes must be based on sound geometry knowledge in that scope [1,2]. Currently, the connectors are the subject of research such as [4,5]. There are also a lot of software supporting design elements such as tess, reduction etc. [6,7,8,9,10].

Computer techniques greatly simplify the design process, but do not absolve a designer from the fact of having the right knowledge. [3] Programs may prompt only some solutions from which a designer must choose one. Prepared development should be cut in the metal. For this purpose punching dies may be used, or expensive but universal CNC machines (in which cutting is carried out by means of plasma, laser, high pressure water, etc.). Such machines are relatively expensive and require proper staff training to operate them.

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2.1 Tees

Figure 1

Figure 2

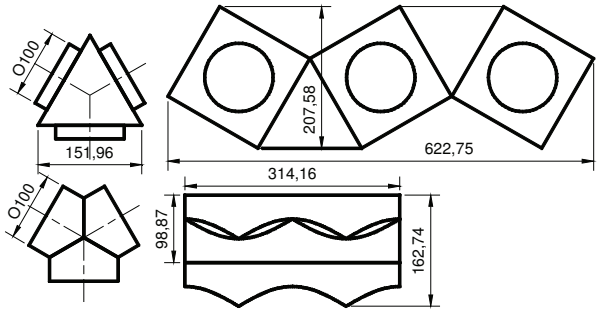

Figure 3

Figure 1 and 2 show commercially available tees. The second tee on the right is an incorrect solution in several aspects, such as flow distortion or unexplained geometric form. Figure 3 shows extensions of both switches, assuming that the inlet pipe diameters are the same and equal to 100 mm. The shape of the connector from Figure 2 can be justified by easier make. This advantage can be achieved in other manner as well, and comparative characteristics of both solutions summarized in Table 1 conclusively show that such a solution in each of these parameters is worse than the standard ones proposed in Figure 1 (from the consumption volume of waste material through the length of the welds connecting elements).

Table 1

Diameter of pipe 100	Material before cutting	Material used	Area of waste	Weld length	Bending edge length	Cutting edge length o
[mm]	[mm^2]	[mm^2]	[mm^2]	[mm]	[mm]	[mm]
Element A	46590,22	42878,90[1]	2474,21	641,33	0	2169,14
Element B	148122,04	84563,05	43560,47	1762,29	607,85	2522,09
A/B	0,3145	0,5071	0,0568	0,3639	-	0,8601

2.2 Adjustable elbows

Figure 4

Figure 5

Very often, the angles at which the axis of the pipeline should be changed are different. Manufacturers offer a certain range of angles, however, sometimes an adjustable element is desirable that can be adapted to the existing pipelines on site. The presented solutions are based on the possibility of deformation of the sheet to some extent. Therefore, the ellipses,

[1] average

which are on the joints, while deforming enable to rotate each component relative to each other. This operation requires skill and security, because sometimes the edges of the pipes are relatively sharp

2.3 Connectors – polygon - circle

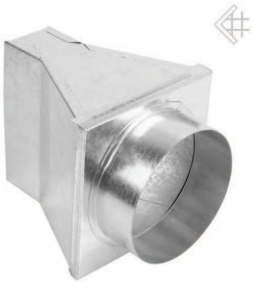

Figure 6

Figure 7

Connecting pipes of different outlet shapes requires knowledge of the principles of design, which allow for optimal, in terms of the geometry, construction of such elements. Figure 6 presents a solution similar in approach to that shown on Figure 2. The connector from Figure 7 is not properly designed, but in this case the balance of the two endings may excuse a constructor

Figure 8

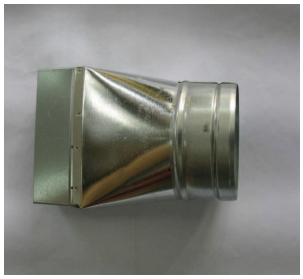

Figure 9

Figure 10

Cable connection with circular cross section with rectangular cable or wider polygonal one requires a complex combination of elements such as a triangle, and most often non-rotating conical surface Figure 8,9,10. However, even in these examples, there are some shortcomings. Top-shaped element appears in Figure 8. Additionally, the component from Figure 10 clearly shows the formation of the cone surface by means of consecutive bends so thus this part resembles a pyramid. The element from Figure 9 shows a corrugation of surfaces which do not fit smoothly.

2.4 Diameter reduction

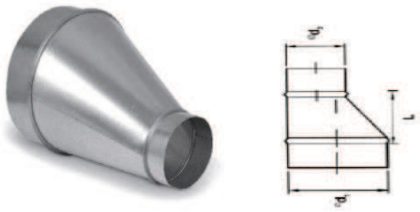

Figure 11

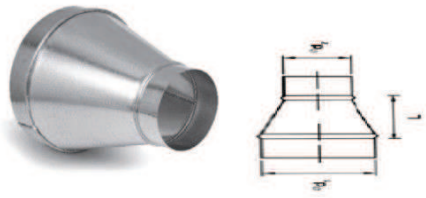

Figure 12

Diameter reduction seems a simple issue for a constructor, which is shown in Figure 11 and 12 (sometimes there are also other solutions). Nevertheless, for a designer that simplicity is not so obvious, because each solution has its pros and cons and an informed choice must be made as far as choosing a solution so that a user does not have problems with the designed installation while its operation. Knowledge of issues related to the geometric characteristics of the rotating and non-rotating cone, such as knowledge of fluid mechanics, will greatly facilitate the selection of the optimal element for a given application.

2.5 Connectors of many wires (five or more)

Figure 13

Figure 14

Figure 15

In the case of connecting multiple cables, the issue of the construction of such a connector gets much more complicated. While designing a constructor must take into account many factors, and his knowledge of geometry must be at a much higher level so that the solution can be regarded as correct in terms of geometry. Three examples in Figure 13, 14, 15 indicate that the designer have not designed solutions in accordance with the rules interpenetration of many cylinders of the same diameter, and sometimes intersecting axes), or have not known how to design such a connection.

3 Parts made of plastic

Items made from plastic give a designer much more possibilities in shaping geometric features. This is due to the methods used for manufacturing (injection molding, extrusion, blow molding, etc.). Each method has its limitations, which may result from e.g. ability to remove from the mold, the formation of voids, etc. Despite greater flexibility in shaping parts made of plastic, it is necessary to make sure they have proper geometric features, as these are reflected in the operation of the item. The shape may for example contribute to the build-up of impurities in the pipes, may cause drop of pressure, etc.

3.1 Tees

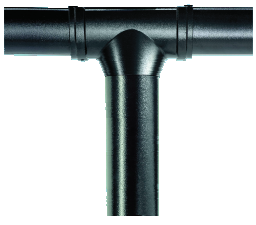

Figure 16

Figure 17

For tees made of plastic a constructor has more possibilities. Thus, Figure 16 shows a tee using rotating cone surface. Thanks to that the generating lines of the cylindrical surface at the bottom are not perpendicular to the generating lines of horizontal cylinder. This solution increases the strength (mostly the same as a rib with two perpendicular plates). A little different character is of an additional space introduced in the tee of Figure 17 In this solution, the introduction of this additional space allowed for a smoother transition within the tee (the connection is larger in area than the standard one). These examples show that their designers have a wealth of knowledge not only in the field of geometry.

3.2 Adjustable connectors

Figure 18

Figure 19

Figure 20

Figure 21

As it can be seen in the case of adjustable connectors, the idea is based on a sphere and a circle (with overlapping center of the sphere and the circle). The second type of adjustable elements of a low-changability components are based on the surface of the sphere and so called honeycomb, which in the outer outline is of a sphere shape (Figure 18,19,20,21).

3.3 Connectors polygon-circle

Figure 22

Figure 23

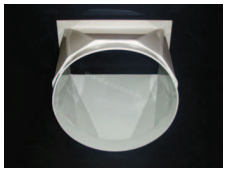

Figure 24

As shown in Figure 22, 23, 24 connectors of a rectangle with a circle are shaped very differently. Figure 22 and 23 resemble recommend shapes a little for geometric reasons, although they have been modified here. It is difficult without a detailed study to determine how these changes have affected the flow of the medium. Figure 24 shows, as in case of the sheet-formed component, a cone part has been replaced by a segment of a pyramid.

4 Conclusions

The presented examples show that there is a high diversity of chimney ducts connectors, ventilation connectors or sanitary systems on the market. The level of accuracy of the design of these connectors is also different, and not just because of the geometric principles. Not knowing the reality of machinery stock it is difficult to regard any solutions as bad. There may be other reasons which influenced the choice of such not the other shapes. What can, and actually should be done, is to extend geometric knowledge of engineers and designers of

these elements, as well as different types of users of different system. This will help to refine the shapes of designed elements. In this way by using optimal geometric elements, defective items will disappear from the market.

5 Acknowledgements

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