must be supplied, which is the very key of interpretation. And one must begin at the end and move backwards to the rest.

## XI

The investigation of forms proceeds as follows: first, for any given nature one must make a presentation[4] to the intellect of all known instances which meet in the same nature, however disparate the materials may be. A collection of this kind has to be made historically, without premature reflection or any great subtlety. Here is an example in the inquiry into the form of heat.

### [Table 1]
Instances meeting in the nature of heat

1. the sun's rays, especially in summer and at noon
2. the sun's rays reflected and concentrated, as between mountains or through walls, and particularly in burning glasses
3. flaming meteors
4. lightning that sets fires
5. eruptions of flame from hollows in mountains etc.
6. any flame
7. solids on fire
8. natural hot baths
9. heated or boiling liquids
10. steam and hot smoke, and air itself, which is capable of a powerful, furious heat if compressed, as in reverse furnaces[5]
11. some spells of weather which are clear and bright through the actual constitution of the air without regard to the time of the year
12. air shut up underground in some caverns, especially in winter
13. all fibrous fabrics, such as wool, animal hides and plumage, have some warmth
14. all bodies, solid and liquid, thick and thin (like the air itself) brought close to a fire for a time

[4] Comparentia is a legal term which refers to the 'presentment' of the defendant or of documents in court. 'Presentation of instances' is intended to preserve something of the legal analogy.
[5] '"Reverbatories" are furnaces constructed with two chambers; an outer one, which has no chimney, but has a passage connecting it with an inner one which has a chimney' (Kitchin).

15. sparks from flint and steel sharply struck
16. any body forcefully rubbed, as stone, wood, cloth etc.; so that yoke-beams and wheel axles sometimes catch fire; and the Western Indians have a way of making fire by rubbing
17. green, wet plants confined and compressed, like roses, peas in baskets; so that hay often catches fire if it is stored wet
18. quicklime sprinkled with water
19. iron as it is dissolved by aqua fortis in a glass without any use of fire; and likewise tin etc., but not so intensely
20. animals, especially internally, where they are constantly hot, though in insects the heat is not perceptible to the touch because they are so small
21. horse shit, and similar animal excrement, when fresh
22. strong oil of sulphur and of vitriol give the effect of heat in scorching linen
23. oil of marjoram and suchlike give the effect of heat when they burn the gums
24. strong distilled spirit of wine gives the effect of heat; so that if the white of an egg is dipped in it, it solidifies and goes white, almost like a cooked eggwhite; and bread dipped in it dries up and goes crusty like toast
25. spices and hot plants, like dracunculus, old nasturtium[6] etc., though they are not hot to the hand (neither whole nor powdered), but with a little bit of chewing are felt as hot to the tongue and palate, and almost burning
26. strong vinegar and all acids cause a pain which is not much different from the pain of heat if applied to a skinless part of the body, like the eye or the tongue, or any other part where there is a wound and the skin has been wounded and the skin has been broken
27. even sharp, intense cold induces a kind of burning sensation: for 'the penetrating cold of the North Wind burns'[7]
28. other things.

We call this the table of existence and presence.

[6] Apparently watercress.
[7] An adaptation of Virgil, Georgics, 1.92–3: 'ne tenues pluviae rapidive potentia solis/acrior aut Boreae penetrabile frigus adurat'.

## XII

Secondly, we must make a presentation[8] to the intellect of instances which are devoid of a given nature; because (as has been said) the form ought no less to be absent when a given nature is absent than present when it is present. But this would be infinite if we took them all.

And therefore we should attach negatives to our affirmatives, and investigate absences only in subjects which are closely related to others in which a given nature exists and appears. This we have chosen to call the table of divergence, or of closely related absences.

### [Table 2]
### Closely related instances which are devoid of the nature of heat

1. the first negative or attached instance to the first affirmative instance.[9] The moon's rays and those of the stars and comets are not found to be hot to the touch; moreover, the sharpest frosts are normally observed at the full moon. But the larger fixed stars are thought to increase and intensify the heat of the sun when it goes under them or approaches them; as happens when the sun is in Leo and in the dog days.

2. negative to the second affirmative instance. The sun's rays do not give off heat in the middle region of the air (as they call it); the common explanation of this is quite good, that that region does not come close enough to the body of the sun, from which the rays emanate, nor to the earth, by which they are reflected. This is clear from the tops of mountains (unless they are particularly high) where the snows are perpetual. On the other hand some travellers have remarked that at the summit of the Peak of Tenerife[10] and also on the Peruvian Andes, the actual peaks of the mountains are destitute of snow; the snow lies only on the lower slopes. And also on the actual summits the air is observed not to be cold but thin and sharp; so that in the Andes its excessive sharpness stings and hurts the eyes, and also stings the mouth of the stomach and causes vomiting. It was also noticed by writers in antiquity that the air at the top of Olympus[11] was so

[8] See note on comparentia at II.11 above.
[9] This and the similar subtitles in each of the 32 Instances is printed as a marginal note in the Latin text.
[10] In the Canary Islands.
[11] The legendary home of the gods in ancient Greece. Hence the reference to the altar of Jupiter (or Zeus) below.

thin that those who made the ascent had to take sponges soaked in vinegar and water and apply them from time to time to mouth and nostrils, because the thinness of the air made it inadequate for breathing. It was also said of that peak that it was so calm and undisturbed by rain and snow that letters traced with their fingers by the celebrants in the ashes on the altar of Jupiter remained there undisturbed till the following year. And even today those who ascend to the top of the Peak of Tenerife do so at night and not in the day; and soon after sunrise are advised and prompted by their guides to make their descent quickly because of the danger (it seems) from the thinness of the air that it will interfere with their breathing and choke them.

3. to the second. In the regions near the polar circles, the reflection of the sun's rays is found to be very weak and unproductive of heat. And so the Dutch who wintered in Novaya Zemlya,[12] waiting for their ship to be freed and released by the pack ice which was holding it fast, gave up hope about the beginning of July, and had to take to the longboats. So the direct rays of the sun seem to have little power even on flat terrain; nor do reflected rays, unless they are multiplied and combined, as happens when the sun approaches the perpendicular. The reason is that at that time the incidence of the rays forms quite acute angles, so that their lines are closer together; by contrast, when the inclinations are high, the angles are very obtuse, and consequently the lines of the rays further apart. However, one should note that there may be many ways in which the sun's rays may work, as well as from the nature of heat, which are not suited to our touch, so that they do not cause heat for us but do produce the effects of heat for some other bodies.

4. to the second. Try this experiment: take a lens made the opposite way from a burning-glass, and place it between the hand and the sun's rays; and observe whether it diminishes the heat of the sun as a burning-glass increases and intensifies it. For it is clear in the case of optical rays that the images appear wider or narrower, according to the thickness of the lens at the centre and the edges respectively. The same thing should be studied with regard to heat.

5. to the second. Carefully try an experiment whether by means of the strongest and best-made burning-glasses the rays of the moon can be caught and combined to produce even the smallest degree of heat. If perhaps the degree of heat is too subtle and weak to be perceptible and

[12] The Dutch explorer Willem Barents died in 1597, in the incident described in the text, while seeking the North-East Passage.

observable to the touch we shall have to try the glasses[13] which indicate the hot or cold constitution of the air. Let the rays of the moon fall through the burning-glass and be cast on the top of a glass of this kind; and take note whether a depression of the water occurs due to heat.

6. to the second. Train a burning-glass on a hot body which is not radiant or luminous, e.g. iron and stone which is heated but not on fire, or boiling water, and so on; and note whether an increase and intensification of heat occurs, as with the sun's rays.

7. to the second. Train a burning-glass on an ordinary flame.

8. to the third. Comets (if we may regard them as a kind of meteor[14]) are not found to have a regular or obvious effect in increasing seasonal temperatures, though dry spells have often been noticed to follow them. Moreover, beams and columns and gulfs of light[15] and such things appear more often in the winter than in the summer; and especially in very intense cold spells, which are also dry spells. But forked lightning and sheet lightning and thunder rarely occur in winter; rather at the time of the greatest heats. But the so-called falling stars are commonly thought to consist of some viscous material which is shining and burning, rather than to be of a powerful fiery nature. But this needs further inquiry.

9. to the fourth. There is some sheet lightning which gives light but does not burn; it always occurs without thunder.

10. to the fifth. Outbursts and eruptions of flame are found in cold, no less than in hot, regions, e.g. in Iceland and Greenland; just as trees too are sometimes more inflammable - more pitchy and resinous - in cold than in hot regions; as is the case with e.g. the fir, the pine and so on. But there has not been enough inquiry into what sort of situation and kind of terrain such eruptions normally occur in, to enable us to append a negative to the affirmative.

11. to the sixth. All flame is more or less hot, and there is no negative attached; however, they do say that the so-called ignis fatuus, which even sometimes settles on a wall, does not have much heat, perhaps like the flame of spirit of wine, which is gentle and weak. The flame which is found appearing around the heads and hair of boys and girls in some serious, reliable histories seems to be still weaker; it did not burn the hair at all but softly flickered around it. It is also quite certain that a kind of gleam

[13] Thermometers
[14] Or perhaps 'heavenly body'.
[15] This seems to be a reference to the aurora borealis.

without obvious heat has appeared around a horse sweating as it travelled at night in clear weather. A few years ago a notable incident occurred which was almost taken for a miracle: a girl's girdle flashed when it was moved or rubbed a little; this may have been caused by the alum or salts with which the girdle had been soaked forming a thick coat on it which became crusted, and being broken by the rubbing. It is also certain that all sugar, whether refined (as they say) or raw, provided it is quite hard, sparkles when broken or scraped with a knife in the dark. Similarly salt seawater is sometimes found to sparkle at night when forcefully struck by oars. And in storms highly agitated sea foam gives off a flash; the Spanish call this flash the lung of the sea. There has not been enough investigation of how much heat is given off by the flame which sailors in the ancient world called Castor and Pollux and today is called St Elmo's Fire.

12. to the *7*th. Everything which has been burned so that it turns to a fiery red is always hot even without flame, and no negative is attached to this a*ffi*rmative. The closest thing [to a negative instance] seems to be rotten wood, which shines at night but is not found to be hot, and the rotting scales of fish, which also shine at night but are not found to be hot to the touch. Nor is the body of the glow-worm or of the fly which they call 'fire-fly' found to be hot to the touch.

13. to the *8*th. There has not been enough investigation of the locations and nature of the earth from which hot springs flow; so no negative is attached.

14. to the *9*th. The negative attached to hot liquids is liquid itself in its own nature. For no tangible liquid is found which is hot in its nature and constantly stays hot; rather heat is superinduced for a time only as an adventitious nature. Hence liquids that are the hottest in their power and operation, like spirit of wine, chemical oil of spices, and oil of vitriol and of sulphur, and suchlike, which quickly cause burning, are cold at first touch. And when water from hot springs is collected in a pitcher and taken away from the springs, it cools down, just like water heated by fire. Oily substances, it is true, are less cold to the touch than watery substances, as oil is less cold than water and silk less cold than linen. But this belongs to the table of Degrees of Cold.

15. to the *10*th. Similarly the negative attached to hot steam is the nature of steam itself as we experience it. Emissions from oily substances, though readily inflammable, are not found to be hot unless just emitted from a hot body.

16. to the *10*th. Just so the negative attached to hot air is the nature of air itself. For we do not experience air as hot unless it has been confined or subjected to friction or obviously heated by the sun's fire or some other hot body.

17. to the *11*th. The negative attached is periods which are colder than normal at that season, which occur among us when the East or the North winds are blowing; just as the opposite kind of weather occurs when the South and West winds are blowing. A tendency to rain (especially in winter) goes along with warm weather, and frost with cold weather.

18. to the *12*th. The attached negative instance is air confined in caves in summertime. But an altogether more thorough investigation is needed of confined air. For first there is a reasonable doubt as to the nature of air in relation to heat and cold in its own proper nature. For air obviously receives heat from the influence of the heavenly bodies; and cold perhaps by emission from the earth; and in what they call the middle region of the air, from cold fogs and snow; so that no judgement can be made of the nature of air from air which is outside and in the open, but might be made more accurately from confined air. And it also necessary for the air to be confined in a jar and in material which neither affects the air with heat or cold of its own, nor easily admits the influence of air from outside. Let the experiment be made therefore with an earthenware jar wrapped in several layers of leather to protect it from the outside air, sealing it well and keeping the air in it for three or four days; take the reading after opening the jar, either by hand or by carefully applying a thermometer.

19. to the *13*th. Similarly, there is some doubt whether the heat in wool, skins, feathers and so on comes from a feeble heat inhering in them because they have been stripped from animals; or also because of a certain fattiness and oiliness, which is of a nature akin to warmth; or simply because air is confined and cut off, as described in the preceding paragraph. For all air cut off from contact with the outside air seems to have some warmth. So let an experiment be made on fibrous material made from flax, not on wool, feathers or silk, which are stripped from animals. Notice too that every kind of dust (which obviously traps air) is less cold than the corresponding whole bodies from which the dust came; just as we also suppose that spray of any kind (since it contains air) is less cold than the actual liquid.

20. to the *14*th. This has no negative attached. For we find nothing either tangible or spirituous which does not take on heat when brought close to fire. These things do however differ from each other in that some absorb

heat quickly, like air, oil and water, while others do so more slowly, like stone and metals. But this belongs to the Table of Degrees.

21. to the *15*th. There is only one negative attached here: notice that sparks are only struck from flint, steel or any other hard substance when minute fragments of stone or metal are struck off from the substance itself, and air subjected to friction never generates sparks of itself, as is commonly thought. Moreover the sparks themselves shoot downwards rather than up, because of the weight of the body ignited, and when extinguished turn back into a sooty substance.

22. to the *16*th. We believe there is no negative attached to this instance. For we find no tangible body which does not manifestly grow warm by rubbing; so that the ancients imagined that there was no other means or virtue of heating in the heavenly bodies than from the friction of the air by rapid and intense rotation. We must ask a further question on this subject: do bodies ejected from machines (as balls from cannons) acquire some heat from the blast itself; so that they are found to be quite hot when they fall? Air in motion rather cools than heats, as in winds, bellows and the expulsion of air through pursed lips. But motion of this kind is not rapid enough to cause heat, and acts according to the whole, not by particles, so that it is no wonder if it does not generate heat.

23. to the *17*th. A more careful inquiry needs to be made of this instance. For herbs and vegetables when green and moist seem to have some hidden heat in themselves. This heat is so slight that it is not perceptible to touch in an individual instance. But when they have been put together and confined, so that their spirit does not escape into the air but nurtures itself, then indeed a noticeable heat arises, and sometimes a fire if the material is suitable.

24. to the *18*th. We must also make a more thorough investigation of this instance. For quicklime sprinkled with water seems to generate heat either because of the concentration of heat previously dispersed (as we said above about stored herbs), or because the fiery spirit is irritated and angered by the water, and some kind of struggle and rejection of the contrary nature takes place[16]. It will readily be apparent which of these it is if we use oil instead of water; for the oil will have the same effect as water in forming a union with the enclosed spirit, but not in irritating it. Wider experiment should also be made with the ashes and limes of different bodies as well as by dropping different liquids on them.

[16] For antiperistasis (rejection of the contrary nature) see II.27 (towards the end).

25. to the *19*th. Attached to this instance is the negative instance of other metals which are softer and more soluble. For goldleaf dissolved into a liquid by means of aqua regis offers no heat to the touch in its dissolving; nor likewise does lead in aqua fortis, nor quicksilver either (as I recall). But silver itself causes a little heat and so does copper (as I recall), and so more obviously do tin and, particularly, iron and steel, which give off not only a fierce heat on dissolving but also violent bubbling. Therefore the heat seems to be caused by the conflict when the strong waters penetrate, pit and disintegrate the parts of the body, and the bodies themselves resist. But when the bodies easily give in, hardly any heat is generated.

26. to the *20*th. There is no negative attached to the heat of animals, except of insects (as remarked) because of the small size of their bodies. For in fish, as compared with land animals, it is more a matter of degree of heat than of its absence. In vegetables and plants no degree of heat is perceptible to the touch, neither in their resin nor in uncovered pith. But in animals a great range of heat is found, both in their parts (for the amounts of heat around the heart, in the brain and around the external parts are all different), and in their occasional states, as in violent exercise and fevers.

27. to the *21*st. There is hardly any negative to this instance. Even animal excrement which is not fresh has potential heat, as is seen by its fertilisation of the soil.

28. to the *22*nd and *23*rd. Liquids (whether denominated waters or oils) which have a high and intense acidity act like heat in tearing bodies apart and eventually burning them, but they are not hot to the touch of a hand at the beginning. They operate by affinity and according to the porosity of the body to which they are attached. For aqua regis dissolves gold, but not silver; on the other hand aqua fortis dissolves silver, but not gold; and neither dissolves glass. And so with the rest.

29. to the *24*th. Make an experiment with spirit of wine on wood and also on butter, wax or pitch, to see whether it dissolves them by its heat. Instance 24 shows its power of imitating heat in producing incrustations. Let a similar experiment be made for liquefactions. Also experiment with a thermometer or calendar glass[17] shaped into a hollow bowl at the top; pour into the hollow bowl some well-distilled spirit of wine, put a lid on it to help keep its heat in; and note whether it makes the water go down by its heat.

[17] vitrum graduum sive calendare. (The term 'calendar glass' is borrowed from Ellis.)

30. to the *25*th. Spices and herbs which are bitter to the palate, and even sharper when swallowed, feel hot. We must therefore see in what other materials they have the effect of heat. Sailors tell us that when heaps and piles of spices are suddenly opened after being long shut up, there is a danger to those who first disturb them and take them out, from fevers and inflammations of the spirit. Similarly, an experiment can be made whether the powders from spices or herbs of this kind do not dry bacon and meat hung over them like the smoke from a fire.

31. to the *26*th. There is a biting and penetrative power both in cold things, such as vinegar and oil of vitriol, and in hot things such as oil of marjoram and suchlike. And they equally cause pain in living things, and non-living things they pull to pieces and eat away. There is no attached negative instance. In animate beings there is no feeling of pain without a sensation of heat.

32. to the *27*th. Several actions of heat and cold are the same, though they work in a quite different way. For snow too seems to burn the hands of boys quite quickly; and cold keeps meat from going off no less than fire; and heat contracts bodies as cold also does. But it is more appropriate to deal with these and similar questions in the Investigation of Cold.

## XIII

Thirdly, we must make a presentation to the intellect of instances in which the nature under investigation exists to a certain degree. This may be done by comparing the increase and decrease in the same subject, or by comparing different subjects with another. For the form of a thing is the very thing itself; and a thing does not differ from its form other than as apparent and actual differ, or exterior and interior, or the way it appears to us and the way it is in reality; and therefore it quite surely follows that a nature is not accepted as a true form unless it always decreases when the nature itself decreases, and likewise always increases when the nature itself increases. We have chosen to call such a table a Table of Degrees or Table of Comparison.

### [Table 3]
### Table of Degrees or Comparison on Heat

First then we will speak of things which have absolutely no degree of heat to the touch, but seem to have only a kind of potential heat, a disposition towards heat, or susceptibility to heat. Then we will move to things which are actually hot or hot to the touch, and their strengths and degrees.

1. Among solid and tangible bodies none is found that is hot in its nature originally. No stone, metal, sulphur, fossil, wood, water or animal corpse is found to be hot. The hot waters in natural baths seem to be heated by accident, whether by an underground flame or fire such as spews out of Etna and a number of other mountains, or from conflict between bodies in the way heat is produced in the solution of iron and tin. And so to the human touch, the degree of heat in inanimate objects is nil; and yet they do differ in degree of cold; for wood and metal are not equally cold. But this belongs to the Table of Degrees on Cold.

2. Nevertheless so far as potential heat and readiness to take fire is concerned, quite a few inanimate things are found which are extremely susceptible to heat, such as sulphur, naphtha and petroleum.

3. Things that have been hot before retain some latent relics of their former heat, as horse dung retains the heat of the animal, and lime, or perhaps ash or soot, the heat of the fire. Thus bodies buried in horse dung exude certain fluids and disintegrate, and heat is roused in lime by sprinkling water on it, as I have explained before.

4. Among vegetables no plant or part of a plant ( as resin or pith) is found which is hot to human touch. Nevertheless (as said above) stored green herbs do grow warm; and some vegetables are found to be hot, others cold, to the interior touch, e.g. to the palate or stomach, or even to exterior parts after a certain time (as in the case of poultices and ointments).

5. Nothing hot to human touch is found in the parts of animals after they have died or been separated from the body. Even horse dung loses its heat unless shut in and buried. However, all dung seems to have potential heat, as in fertilising the fields. And similarly corpses of animals have a latent and potential heat of this kind; so that in cemeteries where burials occur every day, the earth acquires a kind of hidden heat which consumes a recently buried body much more quickly than fresh earth. There is a story that a kind of fine, soft cloth is found among Orientals which is made from the plumage of birds, and has an innate power to dissolve and liquefy the butter which is loosely wrapped in it.

6. Things which fertilise the fields, as dung of all kinds, chalk, sand from the sea, salt and suchlike have some inclination to heat.

7. All rotting has some traces of a weak heat in it, though not to the extent that it can be felt by touch. For things like flesh and cheese, which rot and

dissolve into little creatures, are not felt as hot to the touch; nor is rotten wood that shines at night, found to be hot to the touch. However, heat in rotting things sometimes shows itself by strong, vile smells.

8. Thus the first degree of heat, from things which are felt as hot to human touch, seems to be that of animals, which has quite a wide range of degrees. For the lowest degree (as in insects) is barely perceptible to touch; the highest degree scarcely reaches the degree of heat of the sun's rays in the hottest regions and seasons, and is not too fierce to be tolerated by the hand. And yet they say of Constantius and of some others who were of very dry constitution and bodily condition, that when they were in the grip of highly acute fevers, they almost seemed to burn the hand that touched them.

9. Animals increase in heat from movement and exercise, from wine and eating, from sex, from burning fevers and from pain.

10. At the onset of intermittent fevers, animals at first are seized by cold and shivering, but soon become exceedingly hot; as they also do right from the beginning in the case of burning and pestilential fevers.

11. We should make further investigation of the comparative heat in different animals, as in fish, quadrupeds, snakes and birds; and also by species, as lion, kite, man etc.; for in the common belief fish are quite cool internally, whereas birds are very hot, especially doves, hawks and sparrows.

12. We should make further investigation of comparative heat in the same animal, in its different organs and limbs. For milk, blood, sperm and eggs are found to be moderately warm, and less so than the exterior flesh of the animal when it is moving or agitated. Likewise no one has yet inquired into the degree of heat in the brain, stomach, heart and so on.

13. In winter and cold weather all animals are cold externally; but internally they are thought to be even warmer than usual.

14. Even in the hottest part of the world and at the hottest times of the year and the day, the heat of the heavenly bodies does not reach a sufficient level to burn or scorch the driest wood or straw or even tinder, unless it is intensified by burning-glasses; and yet it can raise a steam from damp matter.

15. The received wisdom of the astronomers makes some stars hotter and some cooler. Mars is said to be the hottest after the sun, then Jupiter, then Venus; the moon is said to be cold and Saturn coldest of all. Among the fixed stars Sirius is said to be hottest, then the Heart of the Lion, or Regulus, then the Dog-star, etc.

16. The sun has more warming power the nearer it approaches the perpendicular, or Zenith, as we should also expect of the other planets in their different degrees of heat; for example, that Jupiter is more warming for us when it lies beneath the Crab or the Lion than when it is beneath Capricorn or Aquarius.

17. We should also expect that the sun itself and the other planets have more warming power at their perigees, because of their proximity to the earth, than at their apogees. And if it should happen that in any region the sun was both at its perigee and close to the perpendicular at the same time, it would necessarily have more warming power than in a region where it was at its perigee but shining more obliquely. Hence we need to make a comparative study of the heights of the planets with regard to their closeness to the perpendicular and their obliquity, for each different region.

18. The sun, and the other planets likewise, are also thought to have more warming power when they are in proximity to the major fixed stars; as when the sun lies in Leo it is nearer to the Cor Leonis, the Cauda Leonis, the Spica Virginis and Sirius and the Dog-star, than when it lies in Cancer, where however it is more towards the perpendicular. And we have to believe that some parts of the sky give off more heat (though imperceptible to touch) because they are furnished with more stars, particularly the larger ones.

19. In general the heat of heavenly bodies is increased in three ways: viz. by perpendicularity, from propinquity or perigee, and from a constellation or company of stars.

20. In general the heat of animals and also of the heavenly rays (as they reach us) is very different from even the gentlest flame or burning objects, and also from liquids or air itself when strongly heated by fire. For the flame of spirit of wine, even in a natural, unfocused form, is still able to set fire to straw or linen or paper; which the heat of an animal or of the sun will never do without burning-glasses.

21. In flames and burning objects there are very many degrees of strength and weakness of heat, but no careful inquiry has been made about them, and so we must deal with them superficially. The flame from spirit of wine seems to be the gentlest of flames; unless perhaps ignis fatuus or flames or flashes from the sweat of animals are gentler. We believe that the next flame is that from light and porous plant matter, like straw, rushes and dry leaves, and the flame from hairs or feathers is not much different. Next perhaps is the flame from wood, especially the kinds of wood without much

resin or pitch, bearing in mind that the flame from less hefty sticks (which are usually bound into bundles) is smoother than that from trunks and roots of trees. This may be commonly experienced in furnaces that smelt iron, in which the fire from firewood and branches of trees is not very useful. Next comes (as we think) the flame from oil, tallow, wax and similar fatty substances which do not have much bite. The most powerful heat is found in pitch and resin, and still more in sulphur, camphor, naphtha, saltpetre and salts (after the crude matter has blown away), and in their compounds, like gunpowder, Greek fire (which is commonly called wildfire) and its different kinds, whose heat is so stubborn it is not easily extinguished by water.

22. We also think that the flame which comes from some imperfect metals is very strong and fierce. But all these things need further inquiry.

23. The flame of forked lightning seems to surpass all these flames; so that it has sometimes melted wrought iron itself into drops, which those other flames cannot do.

24. There are different degrees of heat also in bodies that have been set on fire. No careful investigation has been made of this either. We believe that the weakest is given off by burning tinder, such as we use to start a fire; and the same for the flame from the porous wood or dry cords which are used for firing cannon. Next to this is burning coal from logs and coal, and also from fired bricks and suchlike. Of fired substances we think that fired metals (iron, copper and so on) have the fiercest heat. But this too needs further investigation.

25. Some fired things are found to be far hotter than some flames. For example, fired iron is much hotter and more destructive than the flame of spirit of wine.

26. Many things too which without being on fire are simply heated by fire, like boiling water and air confined in reverse furnaces, are found to surpass in heat many kinds of flame and burning substances.

27. Motion increases heat, as one can see in the case of bellows and blasts of breath; so that the harder metals are not dissolved or melted by a dead or quiet fire but only if it is rekindled by blowing.

28. Try an experiment with burning-glasses in which (as I recall) the following happens: if a burning-glass is placed (for example) at a distance of a span[18] from a combustible object, it does not burn or consume as much

[18] A span is nine inches.

as if it is placed at a distance of (for example) a half-span, and is slowly and by degrees withdrawn to the distance of a span. The cone and the focus of the rays are the same, but the actual motion intensifies the effect of the heat.

29. Fires occurring when a strong wind is blowing are thought to advance further against the wind than with the wind; this is because the flame leaps back with a swifter motion when the wind drops than it advances when the wind is pushing it forward.

30. A flame does not shoot out or start up unless there is an empty space in which it may move and play; except in the blasting flames of gunpowder and suchlike, where the compression and confinement of the flame intensifies its fury.

31. The anvil is much heated by the hammer; so that if an anvil were made of a thinnish sheet of metal, we would think it could be made to glow like fired iron under continued blows from a hammer; but the experiment should be tried.

32. In burning porous substances in which there is space for the fire to move, it is instantly extinguished if its motion is suppressed by strong compression, as when tinder or the burning wick of a candle or lamp or even a burning coal or lump of charcoal is snuffed out with an extinguisher or ground under foot, or suchlike, the activity of the fire immediately stops.

33. Being brought close to a warm body increases heat according to the degree of closeness; this also happens in the case of light; the closer an object is brought to light the more visible it is.

34. A combination of different heats increases heat unless there is a mixture of substances; for a big fire and a small fire in the same place increase each other's heat to some degree; but warm water poured into boiling water cools.

35. The duration of a hot body increases heat. For heat is constantly coming out and passing over and mixing with the preexisting heat, so that it multiplies the heat. A fire does not warm a room as much in half an hour as it does in the course of a whole day. This is not the case with light, for a lamp or a candle in a given spot gives no more light after a long time than it did right at the beginning.

36. Irritation by ambient cold increases heat; as one may see in the case of fires in bitter cold. We think that this occurs not so much because the heat is confined and contracted (which is a kind of union), but because it is exasperated, as when air or a cane is violently compressed or bent, it does not spring back to its former point but goes beyond it to the other side.

Make a careful experiment with a cane or something like that; put it into a flame, and see whether it is not burned more rapidly at the edge of the flame than in the centre.

37. There are several degrees of susceptibility to heat. First of all, note how even a little, weak heat alters and slightly warms things that are the least susceptible to heat. Even the heat of the hand gives some warmth to a small ball of lead or any metal held for just a short time. So easily is heat transmitted and aroused, and it happens in all substances without apparent change to any of them.

38. The readiest of all substances in our experience to take up and to lose heat is air. This is best seen in thermometers.[19] You make them as follows. Take a glass bottle with a rounded belly and a narrow, elongated neck; turn such a bottle upside down and insert it, mouth down, belly up, in another glass vessel which contains water, allowing the bottom of the receiving vessel to just touch the rim of the inserted bottle, and let the neck of the inserted bottle lie on the mouth of the receiving vessel and be supported by it; to do this more easily, place a little wax on the mouth of the receiving vessel; but do not completely seal up the mouth, lest a lack of incoming air should impede the movement we are to speak of; for it is a very light and delicate movement.

The upturned bottle, before being inserted in the other, should be warmed at a flame from above, i.e. on its belly. After the bottle has been placed there, as we said, the air (which had expanded because it was warmed) will withdraw and contract after the time it takes for the applied heat to be lost, to the extension or dimension which the ambient or outside air had at the time when the bottle was inserted, and will draw the water up to this extent. A long, narrow paper should be attached, marked with degrees (as many as you like). You will also observe, as the temperature of the day rises or falls, that the air contracts into a smaller space because of cold and expands into a wider area because of heat. This will be shown by the water rising when the air contracts and going down, or being forced down, when the air expands. The sensitivity of the air to cold and heat is so subtle and sensitive that it far surpasses the sensitivity of human touch; and a ray of sun or the warmth of a breath, to say nothing of the heat of a hand, placed over the top of the bottle, instantly sends the water down in a noticeable manner. We believe that animal spirit has a still more exquisite

[19] vitrum calendare

sense of heat and cold, but is dulled and obstructed by the mass of the body.

39. Most sensitive to heat after air, we think, are bodies which have been newly altered and compressed by cold, like snow and ice; for they begin to melt and thaw with just a gentle heat. After them, perhaps, quicksilver. Then come fatty substances, like oil, butter and so on; then wood; then water; finally stones and metals which are not easily warmed, especially internally. Once they have taken heat, however, they do retain it for a very long time; so that brick, stone or iron, once fired up and plunged and submerged in a basin of cold water, retains so much heat that it cannot be touched for (more or less) a quarter of an hour.

40. The less the mass of a body, the more quickly it warms up when placed next to a warm body; this shows that all heat in our experience is somehow opposed to tangible body.

41. To the senses and to human touch heat is a variable and relative thing; so that tepid water feels hot to a hand in the grip of cold, but if the hand warms up, it feels cold.

## XIV

Anyone may easily see how poor our history is, since we are often compelled to make use in the above tables of the words 'do an experiment', or 'investigate further'; to say nothing of the fact that in place of proven history and reliable instances we insert traditions and tales (though not without noting their dubious authenticity and authority).

## XV

We have chosen to call the task and function of these three tables the Presentation of instances to the intellect. After the presentation has been made, induction itself has to be put to work. For in addition to the presentation of each and every instance, we have to discover which nature appears constantly with a given nature or not, which grows with it or decreases with it; and which is a limitation (as we said above) of a more general nature. If the mind attempts to do this affirmatively from the beginning[20] (as it always does if left to itself), fancies will arise and conjectures and poorly defined

[20] Cf. 1.46, 105.

notions and axioms needing daily correction, unless one chooses (in the manner of the Schoolmen) to defend the indefensible. And they will doubtless be better or worse according to the ability and strength of the intellect at work. And yet it belongs to God alone (the creator and artificer of forms), or perhaps to angels and intelligences, to have direct knowledge of forms by affirmation, and from the outset of their thought. It is certainly beyond man, who may proceed at first only through negatives and, after making every kind of exclusion, may arrive at affirmatives only at the end.

## XVI

Therefore we must make a complete analysis and separation of a nature, not by fire but with the mind, which is a kind of divine fire. The first task of true induction is the rejection or exclusion of singular natures which are not found in an instance in which the given nature is present; or which are found in an instance where the given nature is missing; or are found to increase in an instance where the given nature decreases; or to decrease when the given nature increases. Only when the rejection and exclusion has been performed in proper fashion will there remain (at the bottom of the flask, so to speak) an affirmative form, solid, true and well-defined (the volatile opinions having now vanished into smoke). This takes no time to say, but there are many twists and turns before one gets there. But we will hopefully leave out nothing that leads to this end.

## XVII

When we seem to assign such an important role to forms, we must carefully caution and constantly warn, in case what we say is wrongly taken as referring to the kind of forms which have hitherto been familiar to men's thoughts and contemplations.[21]

First, we are not speaking at present of composite forms, which are (as we said) conjunctions of simple natures, in the common way of things, like lion, eagle, rose, gold and so on. It will be appropriate to deal with them when we get to latent processes and latent structures, and the uncovering of them as they are found in substances (so-called) or compound natures.

[21] Cf. I.51, 65.

Again, what we have said should not be understood (even as far as simple natures are concerned) of abstract forms and ideas, which are not defined in matter or poorly defined. When we speak of forms, we mean simply those laws and limitations of pure act which organise and constitute a simple nature, like heat, light or weight, in every kind of susceptible material and subject. The form of heat therefore or the form of light is the same thing as the law of heat or the law of light, and we never abstract or withdraw from things themselves and the operative side. And so when we say (for example) in the inquiry into the form of heat, Reject rarity, or, rarity is not of the form of heat, it is the same as if we said, Man can superinduce heat on a dense body, or on the other hand, Man can take away heat or bar it from a rare body.

Our forms too may seem to someone to have something abstract about them, because they mix and combine heterogeneous elements (for the heat of heavenly bodies and the heat of fire seem to be very heterogeneous; the redness in a rose or such like is very different from that appearing in a rainbow or in the rays of an opal or diamond; and so are death by drowning, by burning, by a sword thrust, by a stroke and by starvation, and yet they are similar in having the nature of heat, redness and death). Anyone who thinks so should realise that his mind is captive and in thrall to habit, the surface appearance of things, and to opinions. For it is quite certain that however heterogeneous and foreign, they are similar in the form or law which defines heat or redness or death; and human power cannot be freed and liberated from the common course of nature, and opened up and raised to new effectiveness and new ways of operating, except by the uncovering and discovery of such forms. After this union of nature, which is absolutely the principal thing, we will speak later, in their place, of the divisions and veins of nature, both the ordinary divisions and those which are internal and more true.

## XVIII

And now we must give an example of the exclusion or rejection of natures which are found by the tables of presentation not to belong to the form of heat; remarking in passing that not only are individual tables sufficient to reject a nature, but so is every one of the individual instances contained in them. For it is obvious from what I have said that every contradictory instance destroys a conjecture about a form. We do sometimes however provide two or three instances of an exclusion, for the sake of clarity, and to show more fully how the tables are to be used.

Example of exclusion or rejection of natures from the form of heat:

1. By the rays of the sun, reject elemental nature.

2. By ordinary fire, and particularly underground fires (which are furthest away and least affected by rays from the heavens), reject heavenly nature.

3. By the fact that bodies of all kinds (i.e. of minerals, vegetables, the external parts of animals, of water, oil, air and so on) are warmed by simply getting near to a fire or other warm body, reject variation or more or less subtle textures in bodies.

4. By heated iron and metals, which warm other bodies but are no way diminished in weight or substance, reject the attachment or admixture of the substance of another hot body.

5. By boiling water and air, and also by metals and other solids which have been warmed but not to the point of catching fire or redness, reject light and brightness.

6. By the rays of the moon and other stars (except the sun), again reject light and brightness.

7. By comparison with burning iron and the flame of spirit of wine (of which heated iron has more heat and less light, the flame of spirit of wine has more light and less heat), once again reject brightness and light.

8. By heated gold and other metals, which have the densest mass in the whole, reject rarity.

9. By air, which remains rare, however cold it gets, once more reject rarity.

10. By heated iron, which does not increase in size, but keeps the same visible dimension, reject local or expansive movement in the whole.

11. By the swelling of air in thermometers and the like, which moves in space and obviously in an expanding manner, and yet does not acquire obvious increase in heat, once again reject local movement or expansive movement in the whole.

12. By the easy warming of all bodies without any destruction or noticeable alteration, reject destructive nature or the violent addition of any new nature.

13. By the agreement and conformity of similar effects displayed by both heat and cold, reject both expanding and contracting motion in the whole.

14. By the generation of heat from rubbing bodies together, reject fundamental nature. By fundamental nature we mean one which is found existing in a nature and is not caused by a preceding nature.

There are also other natures; we are not composing complete tables, but only examples.

Not a single one of the natures listed comes from the form of heat. One need not be concerned with any of the natures listed in an operation on heat.

## XIX

True induction is founded on exclusion, but is not completed until it reaches an affirmation. In fact an exclusion itself is not in any way complete, and cannot be so at the beginning. For exclusion, quite obviously, is the rejection of simple natures. But if we do not yet have good, true notions of simple natures, how can an exclusion be justified? Some of the notions we have mentioned are vague and poorly defined (e.g. the notion of an elementary nature, the notion of a heavenly nature, the notion of rarity). We recognise and always keep in mind how large a task we are undertaking (to make the human intellect equal to things and to nature) and therefore do not stop at the present stage of our teaching. We go further, and devise and provide more powerful aids for the use of the intellect; and these we now set out. In the interpretation of nature, surely, the mind has to be formed and prepared to be content with an appropriate degree of certainty, and yet to recognise (especially at the beginning) that what is before us depends heavily on what is to come.

## XX

And yet because truth emerges more quickly from error than from confusion, we believe it is useful to give the intellect permission, after it has compiled and considered three tables of first presentation (as we have done), to get ready to try an interpretation of nature in the affirmative on the basis of the instances in the tables and of instances occurring elsewhere. We have chosen to call such a first attempt an authorisation of the intellect, or a first approach to an interpretation, or a first harvest.

A first harvest of the form of heat

Notice (as is quite clear from what I have said) that the form of a thing is in each and every one of the instances in which the thing itself is; otherwise it would not be a form: and therefore there can be absolutely no contradictory instance. And yet the form is much more obvious and evident in some instances than in others, namely in the instances where the nature of the form is less checked, obstructed and limited by other natures. We have chosen to call such instances *conspicuous* or *revealing instances*.[22] Let us proceed then to the actual first harvest of the form of heat.

> In each and every instance, the nature of which heat is a limitation seems to be motion. This is most apparent in a flame, which is always in motion; and in boiling or bubbling liquids, which are also always in motion. It appears also in the intensifying or increase of heat produced by motion; as by bellows and winds (see Instances 29 of Table 3). And similarly with motion of other kinds (see Instance 28 and 31 of Table 3). It is apparent once more in the extinction of fire and heat by any powerful compression which puts the brake on motion and makes it cease (see Instances 30 and 32 of Table 3). It is also apparent in the fact that every body is destroyed or at least significantly altered by any fire or strong and powerful heat; hence it is quite obvious that in the internal parts of a body, heat causes tumult, agitation and fierce motion which gradually brings it to dissolution.

What we have said about motion (i.e. that it is like a *genus* in relation to heat) should not be taken to mean that heat generates motion or that motion generates heat (though both are true in some cases), but that actual heat itself, or the quiddity of heat, is motion and nothing else; limited however by the *differences* which we shall lay out shortly, after adding some caveats to avoid ambiguity.

Heat as felt is a relative thing, and is not universal but relative to each individual; and it is rightly regarded as merely the effect of heat on the animal spirit. Further it is in itself a variable thing, since the same object gives rise to a perception of both heat and cold (according to the condition of the senses), as is clear from Instance 41 of Table 3.

The form of heat should not be confused with the communication of

[22] See II.24.

heat or its conductive nature, by which one body is warmed by contact with another body which is hot. Heat is different from warming. Heat is produced by a movement of rubbing without any preceding heat, and this excludes warming from the form of heat. Even when heat is produced by closeness to heat, the effect is not due to the form of heat but depends wholly on a higher and more common nature, viz. on the nature of assimilation or multiplication, which requires a separate investigation.

Fire is a popular notion without value: it is made up of a union of heat and light in a body, as in an ordinary flame, and in bodies heated till they are red.

Having removed all ambiguity, we must now come at last to the true di*ff*erences which limit motion and constitute it as the form of heat.

> The first di*ff*erence is that heat is an expansive motion, by which a body seeks to dilate and move into a larger sphere or dimension than it had previously occupied. This difference is most obvious in a flame; here the smoke or cloudy exhalation visibly broadens and opens out into a flame.
>
> It is also apparent in all boiling liquids, which visibly swell and rise and give off bubbles; and it pursues the process of its own expansion until it turns into a body which is far more extensive and broadened than the liquid itself, i.e. into steam or smoke or air.
>
> It is also apparent in wood and every kind of combustible thing, where there is sometimes sweating and always evaporation.
>
> It is also apparent in the melting of metals, which (being of highly compact substance) do not easily swell and dilate; their spirit first dilates in itself and so conceives a desire for still greater dilation, then visibly thrusts and forces the more solid parts into liquid form. If the heat is still further intensified, it dissolves and turns much of it into a volatile substance.
>
> It is apparent also in iron or rocks; although they do not melt, they are not fused, but they are softened. This also happens with sticks of wood; they become flexible when gently warmed in hot ashes.
>
> But this motion is best seen in air, which under the influence of a little heat dilates itself immediately and perceptibly; as by Instance 38 of Table 3.
>
> It is also apparent in the contrary nature, that of cold. For cold contracts every substance and forcibly narrows it; so that in spells of intense cold nails fall out of walls, bronze objects split, and glass which

has been warmed and then suddenly plunged into cold cracks and breaks. Air similarly withdraws into a smaller space under the influence of a little cooling; as by Instance 38 of Table 3. But we will speak more fully of this in the inquiry on cold.

And it is no wonder if heat and cold exhibit several similar actions (on which see Instance 32 of Table 2), since two of the following *differences* (of which we are about to speak) belong to both natures; though in this *difference* (of which we are now speaking) the actions are diametrically opposite. For heat gives an expansive, dilating motion, and cold gives a contracting, shrinking movement.

The *second difference* is a variation of the first; namely that heat is an expansive motion, or motion towards a circumference, under the condition that the body rises with it. For there is no doubt that there are many mixed motions. For example, an arrow or a javelin rotates as it flies and flies in rotating. Similarly too the motion of heat is both an expansion and a movement upwards.

This *difference* is apparent in a pair of tongs or an iron poker put in the fire: because if you put it in upright holding it with your hand from above, it quickly burns your hand; but if you put it in from the side or from below, it is much slower to burn the hand.

It is conspicuous also in distillation by means of a retort, which is used for delicate flowers which easily lose their scent. Trial and error has found that one should place the flame above rather than beneath, so as to burn less. For all heat, and not just a flame, rises.

On this subject try an experiment with the contrary nature of cold, as to whether cold does not contract a body by descending downwards just as heat dilates a body by ascending upwards. Take two iron rods or two glass tubes (in other respects equal) and heat them somewhat; place a sponge full of cold water or snow under one and over the other. Our view is that the cooling at its ends will be quicker in the rod with the snow above it than in that with the snow beneath it; contrary to what happens in the case of heat.

The *third difference* is that heat is a motion which is not uniformly expansive throughout the whole of a body, but expansive through its smaller particles, and is at once checked and repelled and bounced about, so that it takes on a back-and-forth motion, always scurrying about, and straining and struggling, angry at the beating it takes; hence the fury of fire and heat.

This *difference* is most apparent in a flame and in boiling liquids; which are incessantly agitated, swelling in small spots and subsiding again.

It is also apparent in bodies which are so tough and compact that they do not swell or gain in mass when they are heated or fired; like heated iron, in which the heat is very fierce.

It is apparent also in a hearth fire burning brightest in the coldest weather.

It is also apparent in the fact that no heat is observable when air expands in a calendar glass without obstacle or counter-pressure, i.e. uniformly and equally. And no particular heat is observable in the case of winds which have been shut up and then burst forth with great violence; that is because the motion is of the whole without a back-and-forth motion in the parts. Try an experiment on this, whether a flame does not burn more fiercely towards the edges than in the middle.

It is apparent also in the fact that all burning passes through the minute pores of the body on fire; so that the burning pits, penetrates, stabs and pricks like a thousand needle points. This is also the reason why all strong waters (if akin to the body in which they act) have the effect of fire because of their corrosive, piercing nature.

The *difference* of which we are now speaking is shared with the nature of cold: in cold the contractive motion is checked by the contrary pressure to expand, while in heat the expansive motion is checked by the contrary pressure to contract.

Therefore whether they penetrate the parts of the body towards the interior or towards the exterior, the explanation is the same, though their strength is quite different in the two cases. For we do not experience on the surface of the earth anything exceedingly cold. See Instance 27 of Table 1.

The fourth *difference* is a variation of the previous one. It is that the motion of pricking and penetration must be quite rapid, not slow, and takes place at the level of the particles, minute as they are; and yet not the very smallest particles, but those which are somewhat larger.

This difference is apparent from a comparison of the effects which fire gives with those made by time or age. For age or time withers, consumes, subverts and turns to dust no less than fire; or rather much more subtly. But because such motion is very slow and by very tiny particles, no heat is observable.

It is apparent also in the comparison between the dissolution of iron and of gold. Gold is dissolved without arousing heat, but iron with a violent arousal of heat, though in a quite similar length of time. The reason is that in gold the entrance of the separating liquid is gentle and discreet, and the particles of gold yield easily; but in iron the entry is rough and forcible and the particles of iron are more stubborn.

It is apparent also to some extent in some gangrenes and flesh rotting, which cause little heat or pain because the putrefaction is delicate.

And this is the first harvest or preliminary interpretation of the form of heat, made by the leave given to the intellect.

On the basis of this first harvest, the true form or definition of heat (of heat as a universal notion, not relative merely to sense) is, in a nutshell, as follows: heat is an expansive motion which is checked and struggling through the particles. And expansion is qualified: while expanding in all directions it has some tendency to rise. And the struggle through the particles is thus qualified: it is not completely sluggish, but excited and with some force.

The thing is the same as far as operation is concerned. This is the sum of it: If in any natural body you can arouse a motion to dilate or expand; and if you can check that motion and turn it back on itself so that the dilation does not proceed equally but partly succeeds and is partly checked, you will certainly generate heat. It is irrelevant whether the body is elementary (so-called) or imbued with heavenly substances; whether luminous or opaque; whether rare or dense; whether spatially expanded or contained within the bounds of its first size; whether tending toward dissolution or in a steady state; whether animal, vegetable or mineral, or water, oil or air, or any other substance whatsoever which is capable of the motion described. Heat to the senses is the same thing; but with the analogy that belongs to our senses. But now we must proceed to other aids.

## XXI

After the Tables of first presentation, after rejection or exclusion, and after making the first harvest on the basis of them, we must proceed to the other aids to the intellect in the interpretation of nature and in true and complete induction. In setting them out we shall continue to use heat and cold when we need tables, but where we want just a few examples, we shall make use of any other examples, so that we may give a wider scope to our teaching without confusing the inquiry.

We shall speak then in the first place of privileged instances;[23] secondly of supports for induction; third of the refinement of induction; fourth of the adaptation of the investigation to the nature of the subject; fifth of natures which are privileged so far as investigation is concerned, or of which inquiries we should make first and which ones later; sixth of the limits of investigation, or of a summary of all natures universally; seventh of deduction to practice, or of how it relates to man; eighth of preparations for investigation; and finally of the ascending and descending scale of axioms.

## XXII

Among privileged instances we shall first bring forward solitary instances.[24] Solitary instances are those which exhibit the nature under investigation in subjects which have nothing in common with other subjects but that very nature; or again which do not exhibit the nature under investigation, in subjects which are similar in all things to other subjects except in that nature. It is evident that instances of this kind cut out the rambling, and are a quick route to confirming an exclusion, so that a few of them are as good as many.

For example: in an investigation of the nature of colour, prisms and crystals, and also dew and such things, which make colours in themselves and throw them outside themselves onto a wall, are solitary instances. For they have nothing in common with the inherent colours in flowers, coloured gems, metals, woods etc., except colour itself. Hence it is easy to infer that colour is nothing other than the modification of a ray of light admitted and received, in the first case through different degrees of incidence, in the second through various textures and structures of body. And these are solitary instances concerned with resemblance.

Again, in the same inquiry, distinct veins of black and white in marble, and variations of colour in flowers of the same species, are solitary instances.

[23] praerogativae instantiarum: so named from the centuria praerogativa, the aristocratic section of the comitia centuriata at Rome, which had the privilege of voting first at meetings and of announcing its vote before the other 'centuries' voted; it thus indicated to the others which way to vote.

[24] instantiae solitariae