

Discipline and Polish: On Wipers and Wiping
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Wiping, a movement of the hand (or other appendage) across a surface, is most often used for cleaning or drying, although it can also be used to apply, more or less evenly, a substance (think staining of wood, waxing a car, and so forth). Sometimes tools are added – cloths, mops, brooms, etc. – which increase reach or coverage, and thus extends the basic idea of wiping to include sweeping, scrubbing, mopping, and abrading.

Virginia Smith, in her excellent *Clean: A History of Personal Hygiene*, discussing the “link between cleansing and survival,” postulates a three-part bodily defense against harmful poison and decay: the body’s internal filters and waste-disposal systems; its senses, which warn against dangerous materials; and “manipulating the outer limbs to attend to the external body surfaces”- wiping.¹ Wiping is not exclusive to humans; gorillas and chimpanzees alike gather leaves to use as wipers, cleaning themselves. Cat owners see their pets do it frequently, moistening a paw to help the cleaning; clearly the tongue alone can be used as a wiper.² Where dirt is danger, there you’ll find wiping. It is the most basic of cleaning activities.³

¹ Virginia Smith, *Clean: A History of Personal Hygiene and Purity*, (Oxford: Oxford University Press, 2007), 9. One body part not a limb and common to many animals is the eyelid, which both wipes and lubricates eyes. Thank you to my HST 200 student Stephen Morris for pointing this out. I’d actually like to thank all my HST 200 students for helping in editing the first couple of pages of this piece.

² In fact, Robert W. Shumaker, Kristina R. Walkup, and Benjamin J. Beck, *Animal Tool Behavior: The Use and Manufacture of Tools by Animals*, (Baltimore: Johns Hopkins University Press, 2011), outlines how birds, monkeys, and other apes use crumpled and chewed vegetable matter to wipe themselves clean of blood, pus, feces, ejaculate, sticky food residues, and other contaminants. Grooming– mostly wiping - is common behavior in animals of all types. See, for example: Katalin Böröczkya, Ayako Wada-Katsumataa, Dale Batchelorb, Marianna Zhukovskayac, and Coby Schal, “Insects Groom their Antennae to Enhance Olfactory Acuity,” *Proceedings of the National Academy of Sciences* vol 110, no. 9 (Feb. 26, 2013): 3615–3620, with cockroaches as the subject.

³ A Google search on “history of wiping” calls forth four pages of hits related to, shall we say, sphincteral hygiene; those are followed immediately by items related to wiping hard drives, other storage media, and browser histories clean; then comes the “wiping out” of various histories (Bill Cosby’s, Indian dynastic, etc.), although buttockal references remain scattered throughout the first ten pages or so. Then surfing wipe-outs, Muslim sock/shoe/foot wiping, various genocides and species eradications, and so forth. Nothing on the history of wiping as a method of cleaning.

If wiping is fundamental to cleaning, so is cleaning fundamental to maintenance.⁴ All maintenance is preventative, that is, is aimed at preventing failure, whether absolute, partial, or just premature. Dirt - contamination - can both cause failure and obscure signs of incipient failure. Where there is complexity in technologies – systems- the opportunities for failure multiply; maintenance becomes more important, and so does cleaning. Add precision to complexity, and even small contaminations threaten reliability. Even in the most complex situations, wiping remains crucial.⁵

Investigating wiping and wipers is a case of what Siegfried Gideon called “anonymous history,” an attempt to investigate “the humble things, things not usually granted earnest consideration, or at least not valued for their historical import,” but which “in their aggregate” have great importance.⁶ I’m going to start with 18th and 19th century examples, and move on to “critical” and “precision” cleaning, along the way encountering the central role of wiping and wipers in the inculcation of technical knowledge and organizational discipline, their importance in mechanical maintenance, and, briefly, the relation between maintenance and innovation, as illustrated by wiping in today’s “high-tech” sector.

Thinking more broadly, it seems clear that, like technical systems, social and cultural systems also need maintenance. Like the technological systems we’ll look at, they are complex, with many moving and intersecting parts, prone to breakdowns, and seem to require disciplined

⁴ The word maintain itself comes from the Latin *manu tenere*, to hold in the hand, emphasizing the connection between maintenance and wiping.

⁵ Donald L Tolliver, *Handbook of Contamination Control in Microelectronics*. (Park Ridge, NJ: Noyes Publications, 1988), 142.

⁶ Siegfried Giedion, *Mechanization Takes Command: A Contribution to Anonymous History*. (Minneapolis: University of Minnesota Press, 2013), 3.

activities on the part of human participants. Behavioral contamination, like regular dirt, disturbs the orderliness of the system. We'll see how wiping plays a role in maintaining social as well as mechanical regularity and reliability.

No written text can better illustrate the importance of wiping for complex technical and social systems than the 1939 movie [Men of the Footplate](#), produced by the London, Midland, and Scottish Railway.⁷ Paying attention to the appearances of wiping and wipers reveal all of the roles they play in maintaining both the machinery and the related work systems. Young Harry's first job as a "cleaner" (the job tellingly known as "wiper" in the U.S.) is "an essential preliminary to his career as a driver" (engineer in the U.S.). Note the widespread wiping going on. Wiping is Harry's route into becoming "familiar with the parts of a locomotive . . . their names, and how they work." Work in the depot, "cleaning, inspection, and repair," makes rail travel "the safest and most dependable form of transport in the world." Wiping is part of the crew's initiation rituals. Note the connection between cleaning and discipline; learning and obeying the rules is foundational to the systems' functioning; the size and dangers of the system require highly disciplined workers. Despite the narration claiming the Harry's promotion to fireman means "it's goodbye to cleaning," almost everyone, driver, fireman, inspectors, has wiping rags in hand or nearby when working. The familiarity with the machines gained while cleaning allows drivers to spot potential trouble.

This 20th century exemplar has precedents in the maintenance of earlier complex sociotechnical systems.⁸ Sailing ships were the "eighteenth century's most complex machine,"

⁷ Men of the Footplate, produced by London, Midland & Scottish Railway, 1939.
<https://www.youtube.com/watch?v=5SEicpqdumI>

⁸ We will return to railroads anon.

and operated in what could be very trying conditions.⁹ Failures could be fatal. The day-to-day workings of a ship for the crew consisted of adjusting the sails to changing conditions; outside of that “were the ordinary tasks of routine maintenance: scraping the decks, repairing the rigging, mending the sails, spinning and knotting yarn, fixing blocks,” activities designed to detect and delay routine failures. The holystone – a slab of sandstone, in various sizes - was the tool of choice for scraping the decks, which was done frequently – often daily. Often used while on knees – hence the name – holystones were sometimes given handles. The wiping action gave the wooden deck a clean smooth surface. Likewise, swabbing the deck was part of shipboard routine – so much so that a common nickname for a low-ranking sailor was “swabbie.”

Ships were kept clean both for safety and for discipline. Moving about the ship safely in rough conditions required that nothing be out of place or loose, that is, that the decks were cleared. But cleanliness was also considered the foundation of a well-run ship and the mark of a good captain and crew. Few were exempt from all cleaning activities; higher-ranking crew members, having usually come up through the ranks, were accustomed to keeping vessels “shipshape.” Richard Henry Dana’s 1840 *Two Years Before the Mast*, perhaps the best-known tale of the 19th century sea, observed that “the discipline of the ship requires every man to be at work upon something when he is on deck,” and that the crewman’s day began with “washing down, scrubbing, and swabbing the decks.”¹⁰ Discipline, indeed, was both a result of, and indicated by, cleanliness:

A visitor anxious to learn the state of the discipline of a vessel had to go forward to her forecabin. If the forecabin were spotless . . . the paint work and

⁹ Daniel Vickers and Vince Walsh, *Young Men and the Sea: Yankee Seafarers in the Age of Sail* (New Haven: Yale University Press), 88.

¹⁰ Richard Henry Dana, Jr., *Two Years before the Mast* (New York: The Modern Library, 1936).15. The day continues: “It is the officers’ duty to keep everyone at work, even if there is nothing to be done but to scrape the rust from the chain cables.” Idle hands clearly not tolerated, and cleaning up clearly the way to ensure there were none.

bright work brilliant . . . then the ship (he might be quite sure) was in pretty taut order.¹¹

The health of the crew depended as well on cleanliness. An early 19th century observer, commenting on some decades of progress in conditions in the Royal Navy, noted that “the improved state of our provisions has done much to promote this improved health; but it is air and cleanliness which has effected the most miraculous degree of that improvement . . .”¹² Regular cleanings were considered crucial, even if, as with frequent holystoning, the decks were worn out prematurely.¹³

The coming of steam to ships, railroads, and other facilities added precision to complexity. High pressure steam engines have sealing issues; steam pressure must be kept in the cylinder, not escape around the piston rod. The seal, usually referred to as the stuffing box, was vulnerable to dirt and grit, which could degrade the seal and render the engine less efficient.¹⁴ All of the moving parts – crosshead, connecting rod, eccentric rods and cranks, all the various links – needed lubrication, and were vulnerable to dirt. Constant cleaning was fundamental to keeping engines functioning efficiently, and for spotting potential reliability issues.

The entry level position on ships with engines was, and is, “wiper.” As with Harry at LMS, wiping on ships was prerequisite to holding higher positions. To become a “qualified crew member” required “at least six months service at sea in a rating at least equal to that of coal

¹¹ John Masfield, *Sea Life in Nelson's Time* (Freeport, NY: Books for Libraries Press, 1969; repr., Select Bibliographies Reprint Series). 127. Originally published in 1905.

¹² A Real Friend, *A Friendly Address to the Seamen of the British Navy*. London: J. Liddle and Son, 1820, 8. The author was Sir Charles Vinicombe Penrose, a Commander in the British Navy.

¹³ The practice was discontinued in the U.S. Navy in the 1930s, when the costs were finally considered too high to bear. See “Army and Navy: No More Holystone” *Time Magazine*, 17 no. 23 (June 8, 1931).

¹⁴ As the name implies, the seal is created when material is packed into a box surrounding the shaft. “Packing” can be a wide variety of materials. One source indicates that early steam engines used “ham rind” for packing, providing both seal and lubricant. http://c-p-i.com/media/cms_page_media/11/cpi%20mech%20pck%20bklt%20US-updte6%2011-.pdf I have not been able to confirm this.

passer or wiper in the engine department.”¹⁵ Wipers did more than just wipe, of course; scraping paint, cleaning the bilge, and so on were parts of the job. Building familiarity with the machines, though, as well as with the routines of a ship, its crew, and its workings, began with wiping.¹⁶

As with sailing ships, steam ships’ safety depended on thorough cleanliness: “He is a very “*dirty engineer*” who keeps his cylinder covers and other works bright, while underneath grease, grease balls, chips, and ashes abound. “*A clean bilge saves the engineers from a wet skin.*”¹⁷ While wipers did the really dirty work, everyone in the engine room cleaned: “In a well-ordered engine room, each watch, in addition to the general duties, is responsible for a definite portion of the cleaning work.”¹⁸ This was true on land as well.

One example: in 1910, *The International Steam Engineer* reported on a union agreement at a brewery in Worcester, MA. Article 5 of the agreement outlined the position and duties of the chief engineer, who would “have charge of the operation and care of the steam and mechanical department of the plant,” issue “all orders and instructions to the assistant engineers, firemen or other workmen,” and assume responsibility for all upkeep and repairs. Tellingly, the last sentence of the article reads “He shall not be required to do any wiping or cleaning, except when standing on watch.”¹⁹ So while wiping was not part of his regular duties, if he was actively

¹⁵ Silas B. Axtell, *Rights and Duties of Merchant Seamen*, New York: Rights and Duties of Seamen Publishing Company, 1920, 16-17.

¹⁶ This remains true today. A web site about gaining shipboard employment today states that ““A person’s time as a wiper on a ship can be regarded as the time of apprenticeship for preparing for a maritime job later in the future.” <http://www.marineinsight.com/careers-2/who-is-a-wiper-on-ships/> accessed 3/14/2016.

¹⁷ An Old Hand, *The Engine Room: Who Should be in it, and What They Should Do* (South Shields: T.L. Ainsley, 1872, 8.

¹⁸ Richard Sennett and Henry J. Oram, *The Marine Steam Engine: A Treatise for Engineering Students, Young Engineers, and Officers of the Royal Navy and Mercantile Marine*. (London: Longmans, Green, and Co., 1898, 429.

¹⁹ *The International Steam Engineer*, Vol. 30 (1916) 254-255.

running the engine, it became so. As with the railroad, rank did not exempt you from basic maintenance.²⁰

Also like the railroad shed, a stationary engineer's job often began as a wiper, and performance in that job was used as a gauge of worthiness for promotion. An anecdote from the early 20th century:

“A chief engineer for one of the large New York hotels writes us as follows: “The plan of starting with soiled waste or rags in wiping the dirtiest parts of an engine or other machine, and of using cleaner waste and rags as you get to the final cleaning of the polished parts and valve gears, seems so logical that one would think every one would take to it rapidly. However, the less experienced and less careful helpers do not always follow it, showing that they lack both the thoroughness and the sense of economy which the really promising engineer must have. *Many employers size up a man by the way he wipes up when he does not know he is being watched*, and by the amount of waste he uses for doing a good job.”²¹

Wiping is thus the instiller and reinforcer of system, and an indicator of suitability for working in the system.

The railroad wiper occupied, for a while, a classic place in tales of the working world. An excellent example is one of the Frank Merriwell stories, “Frank Merriwell, Engine Wiper, of, At the Foot of the Ladder” from 1898. In typical fashion, Merriwell, a nice young college man, down on his luck, seeks and finds a job in an engine house, as a wiper. After proving himself in wiper society by beating up a much larger bully, he sets to work wiping, subject to initiation pranks (“the other wipers took satisfaction in giving him the very dirtiest jobs”), and believing that if he kept at it, “learned everything

²⁰ I'm reminded of my decades working in kitchens, where you learn early that “if there's time to lean, there's time to clean.” In a good operation, everyone, even the owner or manager, understands and adheres to this maxim.

²¹ *The International Steam Engineer*, vol. 42 (1922), 371; italics mine. “Waste” refers to cotton waste, a common wiper substance that, as the name implies, is the waste product of textile manufacturing.

possible,” he “would rise in time.”²² After sundry excitements, encounters, emergencies, melodramas (blind orphan girls, etc.), and tests, Merriwell saves the day. He is promoted in the following story, “Frank Merriwell, Fireman; or, The First Step Upward,” his diligence and obvious potential leapfrogging him over older, more experienced wipers.²³

In the 20th century, the need for cleanliness spread to multiple industries. It should be pretty obvious that wiping continued to be important; think of the scrubbing and wiping involved in preparing and cleaning surgical operating rooms. The emergence of solid state electronics in the 1950s brought extreme complexity and precision together, and added miniaturization, with its demands for cleanliness. Solid state electronics’ function depended on tight control of molecular composition, which necessitated ultra-purity of all inputs and manufacturing environments.²⁴ Even under these demanding condition, wiping remained a steadfast technique.²⁵

²² Gilbert Patten, “Frank Merriwell, Engine Wiper; or, At the Foot of the Ladder” *Tip Top Weekly* no. 118 (July 16, 1898), 1-28.

²³ Gilbert Patten, “Frank Merriwell, Fireman; or, The First Step Upward” *Tip Top Weekly*, no. 119 (July 23, 1898), 1-28. The wiping rags-to-riches story is a familiar trope. Another such tale is Frank Spearman, “The Million Dollar Freight Train: The Story of a Young Engineer on his First Run,” *The Railroad Trainman*, Vol. 26, (1909), 537- 544. It is the story of a wiper, Bartholomew Mullen, who is tasked with driving a freight train with \$12 million worth of silk, during a strike. No engineers available, but Mullen is called; his supervisor explains “He’s a wiper. I took him in here sweeping two years ago. He ought to be firing now, but the union held him back; that’s why he don’t like them. He knows more about an engine now than half the lodge.” (539). His fireman is another wiper: “Neighbor [the supervisor] couldn’t give me anybody but a wiper, sir,” said Bartholomew, in a sort of wouldn’t-that-kill-you tone. The unconscious arrogance of the boy quite knocked me; so soon had honors changed his point of view. Last night a despised wiper; at daybreak, an engineer; and his nose in the air at the idea of taking on a wiper for fireman.” (541) The union had rigged a switch to derail the train, but Bartholomew miraculously works the controls, gives it the gun, and manages to make the train jump back on to an adjacent track. His reward; his own engine as an engineer. Even well into the 20th century, wipers who work hard at self-improvement make good. An ad for ICS (International Correspondence Schools) from 1958 urges potential students to enroll using the example “A young “engine wiper” became head of an automobile empire,” presumably after taking some ICS courses. See *Popular Mechanics*, Vol. 110, No. 9 (July 1958), 9.

²⁴ See Daniel Holbrook, “Controlling Contamination: The Origins of Clean Room Technology,” *History & Technology* 25, no. 3 (2009), 173-191.

²⁵ Donald L. Tolliver, ed. *Handbook of Contamination Control in Microelectronics*, (Park Ridge, NJ: Noyes Publications, 1905). See also Barbara Kanenberg and Edward Kanegsberg, eds., *Handbook for Critical Cleaning* (Boca Raton: CRC Press, 2001).

So-called “precision cleaning,” mandated specified techniques and tools.²⁶

Wiping cloths specially made for clean rooms emerged quickly in the 1950s; low lint, of various absorbencies, and with low static electric potential. By the 1970s, both the ASTM and the IEST began to specify testing techniques for cleanroom wipers. Wiping techniques were stringently imposed: approved wipers, folded in quarters, were used, and personnel instructed to “begin at the rear of the surface and wipe in a straight line from left to right. *After each pass*, expose a fresh area of the folded wiper and with a slight overlap, wipe the next area from the left to the right. This is continued until the entire surface has been wiped.”²⁷

As with other workplace social systems, desired outcomes depend on people doing the correct thing all the time – that is, discipline. Industrial consultant Barbara Kanegsberg, known as “The Cleaning Lady,” puts it this way:

Another important aspect in the contamination prevention process is well-trained clean room personnel and implementation of a clean room personnel system. A comprehensive clean room personnel system defines clean room behavior training and compliance, hygiene, gowning, the clean room entry process, clean room housekeeping rules, clean room monitoring, and auditing procedures.²⁸

A NASA cleanroom managers’ manual from 1969 emphasizes this point; the

“procedures used in the room, his own and his colleagues’ activities, and the daily and

²⁶ Kanegsberg, *Handbook for Critical Cleaning*, iii: “Precision cleaning has been defined as the removal of soil from objects that appear to be clean in the first place.”

²⁷ Tolliver, ed., *Handbook*, 146-147. Italics in original. See: <https://www.youtube.com/watch?v=fgorPVJR-k> and <https://www.youtube.com/watch?v=XqCk1JMBuJE>. The importance of wiping in high-tech environments is outlined in Howard Siegeman, *Wiping Surfaces Clean*. (Amherst, NH: Vicon Publishing, 2004).

²⁸ Kanegsberg, *Handbook for Critical Cleaning*, 436-437.

periodic maintenance of the facility” carefully controlled, “will greatly influence the cleanliness level achieved in the facility.”²⁹

Wiping and wipers, though, also changed to suit the new demands. Cotton waste and other traditional wiping materials no longer sufficed; they often left more particles behind than they picked up. Artificial fibers, including new microfiber fabrics, a Japanese innovation, were much better.³⁰ But even they needed improvements, which often came from users, as the following example demonstrates.

Allied Signal Aerospace’s Miniature Electro-Mechanical Assembly Department, as the name implies, used clean room assembly areas, and thus needed specialized wipers. A 1981 study revealed that only those “knitted from continuous filamentary polyester or nylon yarn” cleaned adequately.³¹ Ten years later even those no longer sufficed, and another study commenced. Wipers were leaving particles in work areas, contaminating assemblies. Research revealed that the edges of the wipers, sheared to size during manufacture, were releasing particles and loose fibers. Allied Signal immediately informed its suppliers, who were “surprised” at the findings. They had missed this fault because the tests they ran “grossly understated” and “totally missed” released particles. Wiper makers immediately began heat-sealing the edges of the wipers, greatly improving their cleanliness.³² Even the most mundane maintenance activities and tools had to change to suit the needs of the system.

Conclusion

²⁹ James W. Useller, *Clean Room Technology*, NASA SP-5074 ed. (Washington, D.C.: National Aeronautics and Space Administration, 1969), 8.

³⁰ Robert Kanigel, *Faux Real: Genuine Leather and 200 Years of Inspired Fakes* (Washington, D.C.: Joseph Henry Press, 2007).

³¹ William B. Harding, "Clean Room Wiping Cloths," (Kansas City: Allied Signal Aerospace, 1993), 5.

³² Harding, "Clean Room Wiping Cloths," 10.

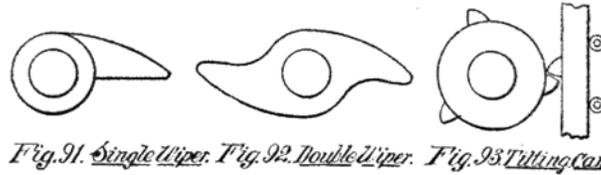
Few things are humbler than a rag. Few actions are more basic than wiping. And yet it serves crucial purposes in maintaining complex systems. In the examples above, wiping is a rite of passage, a site of learning, an indicator of potential, a shared element of workplace culture, an instiller and reinforcer of the systems' reliance on regularity, watchfulness, and proper behaviors. Physical dirt hinders technical systems' performance; improper behavior hampers social and cultural systems' performance. Disciplined maintenance of both systems is necessary; wiping and wipers help eliminate and prevent contamination in both instances.

Appendix: non-human wipers

Researching wipers turns up a lot of opportunities for study. For instance, there are easily a dozen occupational titles that include "wiper."³³ There are also, though, several instances of wiper as mechanism that are worthy of mention here, if for no other reason than to reinforce the ubiquity of wiping as action and metaphor. Here are some examples.

³³ See, for example, the Alphabetical index of occupations and industries: 1960 census of population, U.S. Census. The job category today is collapsed into just a few categories; see http://www.occupationalinfo.org/dot_w4.html.

Wiper Cam: “A lever which has a curved surface and operates with an oscillating movement through an arc great enough to give the required lift to the follower.”³⁴



WIPER WHEELS.—Wiper wheels are cams which give a quick motion to mechanism, the most common form being the single wiper, as shown in Fig. 91.

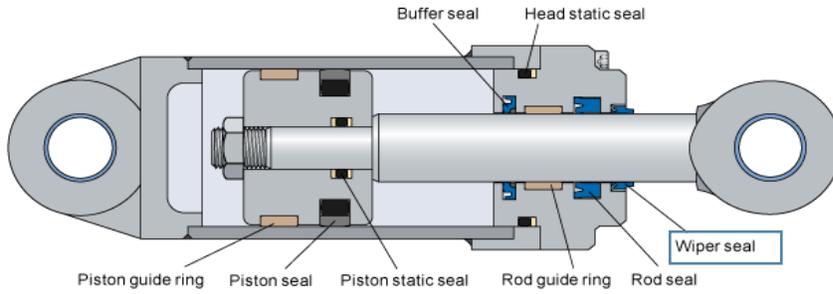
The double wiper cam, Fig. 92, has, in some mechanism, a pronounced difference between the lengths of the two fingers which form the wipers.

The form of cam shown in Fig. 93 is one much used in iron works for setting in motion the tilt hammer. Only three fingers are shown, and by enlarging the cam at least a dozen of these projecting points may be employed.

Wiper cams are commonly used for lifting valves, trip hammers, and so forth. Wiper cams are sometimes in constant contact with a rotating shaft, as in (now old-timey) automotive distributors, where the wiper cam opened the ignition points. Wiper cams generally convert rotating motion to oscillating motion.

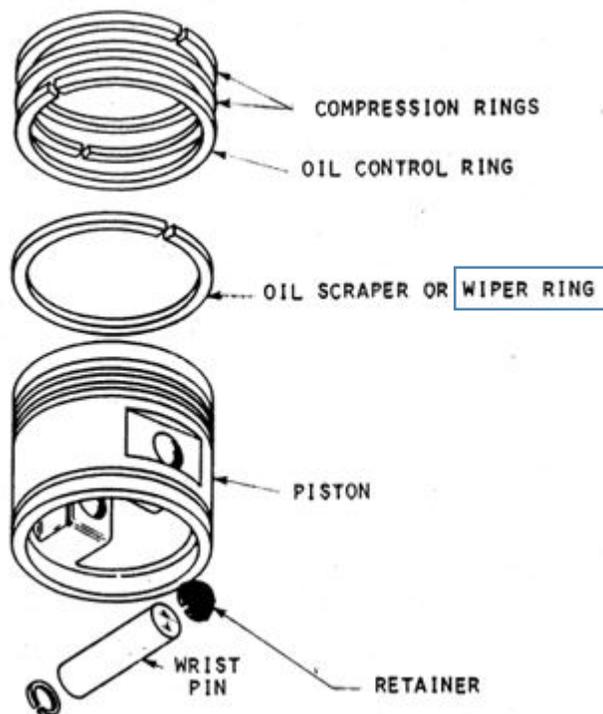
Wiper Seals: in pneumatic cylinders, a wiper seal is the outermost seal, preventing dirt from penetrating further, where it could harm or destroy the inner seals, thereby rendering the device ineffective. Wiper seals are in effect performing the same task as human wipers, but with every stroke of the piston, making them somewhat self-maintaining.

³⁴ Franklin Day Jones, Holbrook Lynedon Horton, and John A. Newell, eds. *Ingenious Mechanisms for Designers and Inventors*, (New York: Industrial Press, 1930), 7.



From: http://www.skf.com/binary/101-146081/76x76/1111%200020%20-%2012393%20w%20-%20EN_tcm_12-146081_76x76.jpg

Wiper Rings: internal combustion engines' need to have seals between the pistons and the cylinders so that the fuel-air mixture can be compressed before ignition. Flexible metal rings seated in grooves around the circumference of the piston serve that function. One of the rings is the “wiper ring,” the job of which is to scrape oil from the cylinder wall, and help prevent crankcase oil from sneaking past the compression rings into the combustion chamber.



Way Wipers: the slides on machine tools, which guide and constrain the tool (or the workpiece), are called “ways.” Way wipers, as you might imagine, are pieces added to keep the ways clean of swarf that could impede clear and smooth movement of the tool (or workpiece). Like wiper seals, these devices replicate the human job of wiper.