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FOREIGN TECHNOLOGY DIVISION



METAL CHANGES FORM

by

Ye. Muslin



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## UNEDITED MACHINE TRANSLATION

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METAL CHANGES FORM

By: Ye. Muslin

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**U. S. BOARD ON GEOGRAPHIC NAMES transliteration SYSTEM**

Block	Italic	Transliteration	Block	Italic	Transliteration
А а	<i>А а</i>	A, a	Р р	<i>Р р</i>	R, r
Б б	<i>Б б</i>	B, b	С с	<i>С с</i>	S, s
В в	<i>В в</i>	V, v	Т т	<i>Т т</i>	T, t
Г г	<i>Г г</i>	G, g	У у	<i>У у</i>	U, u
Д д	<i>Д д</i>	D, d	Ф ф	<i>Ф ф</i>	F, f
Е е	<i>Е е</i>	Ye, ye; E, e*	Х х	<i>Х х</i>	Kh, kh
Ж ж	<i>Ж ж</i>	Zh, zh	Ц ц	<i>Ц ц</i>	Ts, ts
З э	<i>З э</i>	Z, z	Ч ч	<i>Ч ч</i>	Ch, ch
И и	<i>И и</i>	I, i	Ш ш	<i>Ш ш</i>	Sh, sh
Й й	<i>Й й</i>	Y, y	Щ щ	<i>Щ щ</i>	Shch, shch
К к	<i>К к</i>	K, k	Ъ ъ	<i>Ъ ъ</i>	"
Л л	<i>Л л</i>	L, l	Ы ы	<i>Ы ы</i>	Y, y
М м	<i>М м</i>	M, m	Ь ь	<i>Ь ь</i>	'
Н н	<i>Н н</i>	N, n	Э э	<i>Э э</i>	E, e
О о	<i>О о</i>	O, o	Ю ю	<i>Ю ю</i>	Yu, yu
П п	<i>П п</i>	P, p	Я я	<i>Я я</i>	Ya, ya

\*ye initially, after vowels, and after ъ, ь; e elsewhere.  
 When written as ë in Russian, transliterate as yë or ë.  
 The use of diacritical marks is preferred, but such marks may be omitted when expediency dictates.

**GREEK ALPHABET**

Alpha	A	α	•	Nu	N	ν
Beta	B	β		Xi	Ξ	ξ
Gamma	Γ	γ		Omicron	Ο	ο
Delta	Δ	δ		Pi	Π	π
Epsilon	E	ε	•	Rho	Ρ	ρ ϑ
Zeta	Z	ζ		Sigma	Σ	σ ς
Eta	H	η		Tau	Τ	τ
Theta	Θ	θ	•	Upsilon	Υ	υ
Iota	I	ι		Phi	Φ	φ ϕ
Kappa	K	κ	•	Chi	Χ	χ
Lambda	Λ	λ		Psi	Ψ	ψ
Mu	M	μ		Omega	Ω	ω

## RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English
sin	sin
cos	cos
tg	tan
ctg	cot
sec	sec
cosec	csc
sh	sinh
ch	cosh
th	tanh
cth	coth
sch	sech
csch	csch
arc sin	$\sin^{-1}$
arc cos	$\cos^{-1}$
arc tg	$\tan^{-1}$
arc ctg	$\cot^{-1}$
arc sec	$\sec^{-1}$
arc cosec	$\csc^{-1}$
arc sh	$\sinh^{-1}$
arc ch	$\cosh^{-1}$
arc th	$\tanh^{-1}$
arc cth	$\coth^{-1}$
arc sch	$\operatorname{sech}^{-1}$
arc csch	$\operatorname{csch}^{-1}$
—	
rot	curl
lg	log

### GRAPHICS DISCLAIMER

All figures, graphics, tables, equations, etc. merged into this translation were extracted from the best quality copy available.

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Page 159.

METAL CHANGES FORM.

Ye. Muslin.

How to make a 1,000,000 ton press.

Thousandfold reduction/descent in the weight of equipment. Napoleon and the engineer Molar. New technological process - thermo-pressure forging.

Foundation of the building of the museum of art and crafts a Paris was damaged to such an extent, that the walls of main hall constantly settle, they are overhung outside and even threaten with incidence/drop. Napoleon I will order to manufacture investigation and to present the estimate of expenses for the correction of



building. Special board after careful research will propose to break walls, to place new foundation morer deeply and to derive on it new walls. Flow rates had to be 10 million francs. Napoleon this will seem much, and matter will stop. In a year again they will address about this and will show Napoleon entire danger, which can undergo inhabitants, and the visitors of building, if we leave him without the corrections.

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They will again call board, and again it will require 10 millions. Specialists already will think over to break walls. They are assembled it will dig out ten deep wells 40 feet in depth, to place in them granite columns, to fasten on them elevating screws and to build up by them walls. Napoleon will not again affirm project.

Then to emperor is young inventor, the engineer Molar, and he will be taken to manufacture the repair whose cost/value composes one tenth part of those sums, that require both boards. On Napoleon's order to it they immediately give out a million of francs, and inventor will approach toward work. Within the walls of building, he crders to bore two series of holes and to push through through them thick iron bolts with coarse thread. To each bolt allot on two four-valve anchors and they fastened them by nuts. Then to the ends



of the bolts they will hang up the braziers also of sheet iron. Each morning workers open in braziers fire/light, and when bolts are heated and are lengthened, they tighten nuts. After being cooled, bolts tighten walls, and everything begins first. Through two weeks of wall, they will level off, after which will correct foundation. To entire repair it will leave half million of francs. Those who were remaining 500 thousand Napoleon will present to inventor, having in addition awarded by his order.

Such the content of story "as in city Paris they will repair house", written to Leo Tolstoy for children's readers.

As see, French engineer sufficiently ingeniously utilizes force of thermal expansion and compression of metals. Actually, this force is colossal. To calculate it is easy by prime formula, known from strength of materials and which says, that the force from which attempts to be expanded the compressed heated rod, is equal to the product of the modulus of elasticity of material by the coefficient of its linear expansion, by the cross-sectional area of rod and by a difference in the temperatures before and after heating.

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Heating small cube made of chrome-nickel steel - Chromansil -

with the side of 10 centimeters, it is possible through several seconds to obtain effort/force into 1000 tons. Moreover note that for this is required virtually no equipment.

The basic users of many thousand-ton pressures in industry, it is logical, "pressure specialists," specialists in working of metal by pressure. Transfer/converting to stamping of ever larger parts, they require of the mechanical engineers of creation of ever more powerful presses. Indeed on each square centimeter of blank it is necessary to press with the force approximately five tons. To say nothing of the fundamental technical difficulties of their construction, recall only that the power of quite large press in the world comprises now 70 thousand tons. This is the limit of our possibilities until today. But thus with the aid of thermo-pressure forging - the method, which uses thermal expansion of materials, recently proposed by Moscow inventors to M. Zakharovs, A. Mesnyankin, A. Sizov and Yu. Sudarenkov (author's certificate 151186) - it is possible to stamp the parts, which require effort/forces although into a million of tons. New method does not require unique equipment and it is accessible to each enterprise in which there is a vertical turret lathe, necessary for the manufacture of home-made equipment.

The idea of thermo-pressure forging will arise in inventors under following facts. Once for them it is necessary to repair the

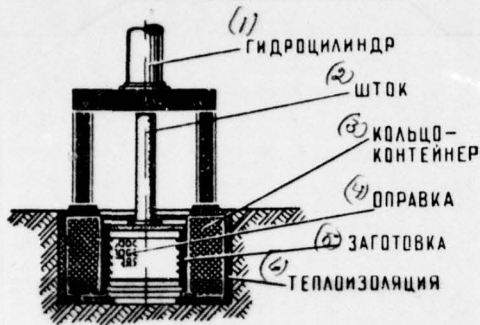
container of powerful hydropress. This container is several thick-walled tubes, with interference inserted into each other. It will happen so that core tube will "drop through," i. e., <sup>its</sup> a diameter will be to the pair of millimeters less than it is required.

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In order not to throw out it into waste/reject, engineers will decide body tube to heat feasible and to insert between them packing - the convolute into tube millimetric duralumin plate. So they will make. But when tube will cool off, it with this force will compress packing, that aluminum, as tests, will begin to escape/ensue from clearance. This case will strike inventors against the thought to utilize forces of thermal expansion for the stamping

The designed by them setting up which they were call/named thermal press, is the massive steel ring, dropped into pit and surrounded by heat insulation. Ring is heated to stamping temperature, and this temperature is maintained constant. Inside ring they insert cold tubular blank, while inside blank - the massive metallic dummy, employed by mandrel/mount. On the external lateral surface of mandrel/mount, it is plotted/applied relief - the fin/edge, the grooves, the reverse/inverse facts which must be extruded on blank.





Thermo-press.

Key: (1). Hydraulic cylinder. (2). Stock/rod. (3). Ring-container.  
 (4). Mandrel/mount. (5). Blank. (6). Thermal insulation.

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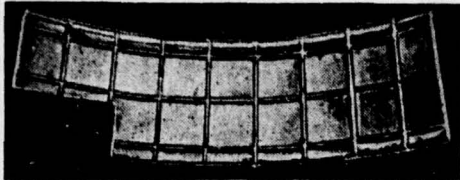
After mandrel/mount will occupy operating position, it to heat. Being heated, it "grows stout", it is given out, it increases in diameter, it pinches the metal of blank and forces its leak, to fill each deepening on mandrel/mount. Is most better utilized induction heating by alternating current. The appearing eddy currents pulse with frequency of 50 per second and that and matter they shake mandrel/mount, they force it to vibrate. In this case, descends the friction between the blank and the stamped surface, substantially is



decreased required working effort/force. After the filling with the blank of the relief of mandrel/mount through the drilled in the latter channels, they start the cooling fluid. Mandrel/mount again is compressed, and it they easily remove from outer ring - container - together with finished part. Cooling they conduct further - and thus from mandrel/mount slips off the stamped part. Its internal surface, as wafer, is covered with the frequent network of grooves and fin/edges, indentations, lugs, thickenings. To obtain of this type part - tube with arbitrary internal relief - in any other manner is impossible. In any case all the undertaken, until now, attempts will prove to be unsuccessful. They test, for example, to resort to sectional stamping, i. e., to stamp flat blank consecutively, in parts, and then to bend it into reel/cylinder and to weld. However, blank from one impact/shock of die/stamp to the other manages to cool off, it is necessary to heat it again, size/dimensions begin "to crawl", the assigned/prescribed relief inadmissibly is distorted. They test to obtain airfoil/profile by rolling, but cross ribs in this case inevitably are undermined, by them are formed cracks.

Remains, true, casting, but to each designer it is known that the castings on the strength not into which comparison go with those who were die-forge/stamped.

So that thermo-pressure forging thus far is located outside competition. During the manufacture of tube blank of aluminum or magnesium alloys with a diameter of two and with the height/altitude the one and one-half meter is developed the effort/force of the order of the fourth of a million of tons. And in order to build up it three or four more times, it is necessary to overcome no fundamental difficulties. With this method drops off the need in heating furnaces for the blanks: thermo-press combines in itself and power and heating devices. Without speaking already about simplicity of construction in comparison with usual press - here there is neither motion work nor bearings nor pumps nor conduit/manifolds - thermo-press gives colossal gain in metal content. As is known, the weight of press with the working effort/force of 50 thousand tons composes 15-20 thousand tone, whereas the weight of the thermo-press of similar power will compose a total of of 25-27 tons - almost thousand times it is less ! True, the productivity of thermo-press are small - to one part it is required about two hours - then from it is possible to place in shop several pieces, and for the maintenance of them all it will be sufficient one bridge crane. The value of the stampable parts is limited in no way. On the contrary, than the diameter of the part more, the more the thermal deformations of mandrel/mount in to stamp becomes more easily.



Piece of panel from under thermo-press.

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Virtually this method is suitable for the diameters more than half meter. Special tests will confirm the service life of the parts of thermo-press itself. So, the mandrel/mount, heated and cooled thousand of times, will not crack, will not change their size/dimensions, its material will undergo no structural changes, its mechanical properties will not deteriorate. Of course, heating one ought not to conduct above 500° - the temperature of structural changes in steel, but for the aluminum and magnesium alloys of this, it is more than sufficiently. As concerns the ring of container, about it to worry generally something: it is located simple-after all under the "hot-house" conditions: neither jerk/impulses nor vibrations, pressure grows gradually, temperature constant. Well a stock/rod, traverse are not virtually loaded.

Although the thermo-presses first of all are intended for stamping the cylindrical parts with the external and internal relief, it is easy to adapt them for conical spherical and even flatware. In the latter case the press will be of two traverse, connected columns, with press-stock/rods in the middle. At the ends of press rods there are mandrel/mounts between which is placed the blank. Columns and press-stock/rods are equipped by heating cell/elements. First heat columns. They are lengthened, mandrel/mounts are separate/expanded, and between them they insert blank. Then are heated press-stock/rods. They perfectly still squeeze blank. Now press-stock/rods are cooled, and blank without any effort/forces can be taken out outside.

The fangle is successfully tested and it is already implemented in the enterprise where work inventors. Because of its unique simplicity and great technological possibilities, it will be widely applied for sure in industry.

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Infinite stamping.

Moscow engineers's new method makes it possible heating to



decrease, and the degree of strain to boundless increase. "heat death" and tortoise velocity make it possible to stamp brittle cast alloys.

Boris Pavlovich Rayskiy, hero of the novel of Goncharov "Otryv" in youth passionately loves to draw. Once he will thoroughly draw female head, but portrait all the same appears by some lifeless. Then it takes teacher, it will add three or four prime, yes it will make on point in each eye - and eyes suddenly will begin to look, accurately living.

The same frequently occurs also in technology. You can apply the strongest and most exotic methods, design the most complex assemblies and not achieve success itself. But it is worth placing such thus "small points", introducing an elusive at first glance change in the technological process, as impossible will become possible. So, bulky equation, hundred years not yielding to mathematical geniuses' effort/forces, becomes elementary, it is worth only removing rods from the designation of the higher derivative or lowering to unity degree of mysterious X.

Although is known many different forms of hot die forging, with all with them, is retained one and the same sequence of actions, moreover sufficient-after all is unreasonable. They do heat metal in

furnaces, high-frequency inductors or baths, after it will be achieved the assigned/prescribed temperature, it they recover from heating device and they feed under press or hammer. Thus far blank they transfer, they pack in instrument finally deform, it continuously cools off. But this in the final analysis makes the quality of production worse, it limits technological possibilities. And this is why.

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Each metal or alloy has the determined temperature interval in which it is possible it to stamp. Once blank cools off, it must be heated strongest possible so as to have a reserve according to temperature, so that it would not cool off under the die/stamp lower than permissible limit. Well, and excess heating leads to the overexpenditure of energy, to the rapid wear of heating devices finally to grain-growth, which makes the metallographic structure of part worse. Due to cooling it is necessary to hurry, "to hammer iron, thus far it is hot". But an increase in the rate leads to hardening of metal, to an increase in the required power of press. Moreover however hurry, but after wrought alloys on the basis of titanium, nickel, cobalt, chromium and magnesium, i. e., after the most heat-resistant and most promising materials of contemporary power engineering, aviation, missile construction with their narrow

intervals of stampability nevertheless you will not ripen. In order to bring treatment to end, blanks of them it is necessary to heat in several times. As a result sharply increases the labor consumption, and main, begins intergranular corrosion, manage to burn out the valuable additions, which impart to material all its remarkable properties.

Thus if blanks do not cool off .... Stamping it would be possible to conduct at the constant most favorable temperature, somewhere near lower boundary of the permissible interval, it would be possible to utilize the so-called "technological plasticity", which specify the phase transformations, which take place in, until now, unrealizable narrow temperature boundary/interfaces, possible it would be .... Yes, little whether what possible !

Moscow engineer-inventors Aleksandr Borisovich Gerchikov, Julias Grigor'yevich, Kaplin and Semen, Zinov'yevich Filgin, occupied by the selection of the best stamping lubrications, will arrive at the conclusion that the dreams of "pressure specialists" not so are already unrealizable.

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For this it is necessary only somehow to change the



establish/installed order: not to transfer blank of heating device under press, but to stamp it directly on the spct submerged to the continuously preheated fusion/melt of any salts or thermoresistant oils. Strictly, in this maximally simple idea is included the main essence of the invention (author's certificate 159382), which literally revolutionizes traditional technology of stamping and forging. Loses force proverb "hammer iron, thus far it is hot": the temperature of blank, which is found as in state "the temperature of blank," thermal equilibrium with heating medium, by entire its volume always remains constant. But once nowhere to hurry, then punch/male die can be forced to move hardly, at tortoise velocity. it seems, for which this is necessary, indeed the rates of all technological processes usually vice versa try to increase. But the whole point is that this slow "half-asleep" stamping offers before us completely new possibilities.

As is known, all alloys are divided by two large groups are foundry and deformed. Cast alloys possess highest heat resistance, but are extremely brittle and fear impact/shocks as glass. It is not possible to stamp them virtually: negligible plasticity allow/assumes the negligible degrees of strain. Another matter, slow stamping in melt. Thus the halves of die/stamp hardly noticeably will be shifted to some lot of millimeter. Plasticity is exhausted, the voltages in part rapidly grow, it has already been assembled to crack. But ...



indeed part is heated, in it continuously occurs the recrystallization, the restoration/reduction of original structure. As unchangeable rubble, again returns to its plasticity, and again is shifted/sheared die/stamp on several hundredths.

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By such steps stamping it is possible to continue infinitely, provided the velocity of the motion of die/stamp it does not disturb the leisurely going in blank processes of recrystallization.

But why cast alloys as it does want to compulsorily stamp? In what here main advantage? First, contemporary heat-resistant alloys are so capricious that, as a rule, one, and that also two thirds of casting depart to waste/reject. During stamping the waste/reject does not usually exceed two percent. Furthermore, stamping refines, it makes metal softer, it is more plastic, it makes it possible to perform from it the parts, which experience/test vibrations and impact/shocks, for example turbine blades. But each degree of an increase in their refractoriness noticeably raises the power of turbines, it improves their fuel cost-effectiveness/efficiency.

Stamping in fusion/melt protects metal from oxidation, from the saturation of it by harmful elements. Is especially important

the high lubricating power of fusion/melt. Each "pressure specialist" knows that the thinner blank, facts more difficult it to stamp, the more manifests itself the friction between the halves of die/stamp and its butt ends. When blank is converted into fine/thin pancake, then to raise the power of press is already useless: transforms not blank, but die/stamp itself. Here because of a sharp reduction/descent in the friction succeeds in stamping parts with a thickness in one-two-three of millimeter, for example the same of turbine or compressor blade. Blanks is not necessary more to mill, to turn, to grind. From under press they go immediately to polishing. On the colossal advantage of new technology, it is possible to judge, knowing that to blades comes almost the half of work on the manufacture of turbines and compressors. Furthermore, decrease in the departure/withdrawals allows 5-10 times (!) to reduce the consumption of the expensive alloys.

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Interestingly is solved problem of tool. Actually, if for parts we do utilize most heat-resistant of the existing alloys, from what then it is made die/stamp itself? Indeed it is heated here to the same temperature. It turns out that die/stamps can be manufactured from ceramics: heat resistance in it is higher than in any metal, but brittleness to us is not terrible: pressure during stamping in fusion/melt builds up very smoothly. For stamping using new method, completely match up usual hydraulic presses, it is necessary to only supply them with regulators, baffles. To even conveniently use the thermal presses, working effort/forces in which are created because of thermal structural distortions. Changing the rate of heating press-stock/rods, it is possible to regulate the velocity of working stroke within which conveniently limits.

Fire under press.

The burning paste does heat blanks prior to the stamping

That to more easily heat - small grain or massive heavy ingot?

- Of course, grain, it will answer, without a moment's hesitation, each, who passed in the secondary school to physicist. - Of grain mass is less, which means, is less heat capacity.

In spite of its apparent persuasiveness, this answer/response is correct not always. Than to the heating temperature it is higher, the more the heat it emits any hot body into surrounding space. According to the law of Stefan-Boltzmann, these losses grow fast, of proportionally to the fourth degree absolute temperature. But since emission/radiation occurs from surface, but the ratio of surface to overall mass of grain much more than in massive ingot, also heat it loses faster.

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Recall at least the sparks, which fly from under the grindstone, these tiny metallic specks, incandesced to thousand-degree temperatures and which die out in flight. To attempt not to give to them cool off, pumping by their new heat flow, so it is difficult as to fill bottomless buoy/barrel. The same occurs with fine/thin metallic plates. Possessing large surface and low mass, they instantly cool off, even being are heated red hot. This fact



extremely complicates press men's work. Will not have time they to incandesce sheet blank and to transpose it of flame or induction furnace under press, as it already will cool off. In order to compensate for rapid cooling, blanks they specially superheat, making in this case structure and the mechanical properties of metal worse, they try to transpose them of furnace under press as fast as possible finally heat preliminarily die/stamps themselves, provided they less take/selected heat from blanks. But frequently all these contrivances do not give the desired effect, but during stamping of the tungsten, molybdenum and other rapidly oxidized in air metals and alloys technology is complicated still no longer is required vacuum, shielding inert media, etc.

Instantaneous heating to optimum temperatures directly in working tool it is direct during deformation - it will thus be ideal solution of problem from the viewpoint of the metallographers. But both the this heating to virtually carry out - this already another question. Apparently, will be required the powerful high-quality settings up, which are expensive and complex in maintenance electronic systems .....

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To the honor of Moscow Engineering Inventors Yevgeny Vladimirovich

Vasiliev and Yakov Sergeyeovich Gabrielyants the proposed by them for this purpose method is maximally simple, cheap, requires no accessories and it is accessible even collective farm shop (author's certificate 172866).

You, probably already hear about the preserved dinner dishes, packed into special tin cans with the plotted to their bases hot mixture. It will open box, it will present lit match to base, and hot soup or hot to your services.

On the same way will go our inventors, who created of their kind "canned foods" for press. Fine/thin sheet blank they will grease by a layer of combustible substance with large calorific value. Then they will lie/fall blank in die/stamp and for instant to working stroke will set fire combustible substance. Plate will flare up immediately over an entire surface and rapidly it will be heated to necessary temperature. Since the burning is continued and then, when punch/male die goes down, then during of entire strain blank retains the necessary plasticity.

Which new possibilities do open/disclose before stamping this unusual method of heating?

First, is not required neither furnace nor any other heating

equipment, for example the installed into die/stamps electroelements, which expend much energy.

In the second place, the optimum plasticity, which it is possible to control in time, keeping track of the temperature in the isolated points of blank with the aid of thermocouples, makes it possible to obtain large drawing, for one impact/shock of punch/male die to stamp parts of the hard-to-deform alloys, for example titanium for which are required several heatings.

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Thirdly, due to the short duration of heating even the such easily oxidized in air materials, as tungsten and molybdenum, do not manage to be oxidized, so that there is no need for for vacuum systems and protective atmosphere, which incredibly complicate and which raise in price production process, which make it unattainable for the larger part of the enterprises. The experiments, carried out on the millimetric plates of molybdenum, from which stamp thus cylindrical cups, will confirm this fact: on the surface of parts, will not be the trace of oxide.

Combustible mixture will be applied to plates without special work, then they simply dip, for example, into the opening of powder



in acetone, cover/coat with the insulating safety film and place with the upright strut in cabinet drier. It is obvious, dipping and drying to easily mechanize and even to automate.

Finally, one additional advantage of new method consists in the fact that the punch/male die and matrix/die always remain cold and are not tested alternating heatings and coolings. This contributes to the service life of the expensive instrument.

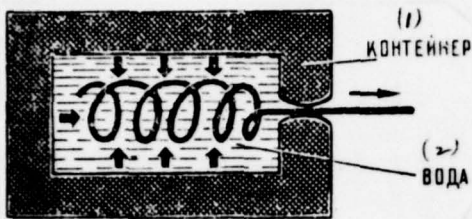
Shooting helix.

The hydrostatic pressure forging of the bimetallic blanks

Machining metals by extrusion has already been known for several dozen years. The blank - a thick metal bar - places into container - the vessel with thick strong walls. In the forward section of the container, there is conical bore - matrix/die, rear wall the container does not have. It replaces mobile instrument, press die - the solid piston, made made of highly durable steel.

Worker will press knob/button. Thousand-ton bulky object of immense press by value with six-storied house will shudder and by whole its incredible force it will be piled to press die. Press die slowly crawls down, extruding metal from container. Through the figure hole of matrix/die, taking its form, it will begin to creep out blank. Specifically, to creep out, since the velocity of its motion does not exceed several millimeters per second. The fact is that at larger velocity begin to be torn the external filaments of blank and on the surface of article they are formed the flaws are "rag bolt/brushes". But furthermore, at press it is simply insufficient the power: compacting pressure reaches to 10 thousand atmospheres yes the friction of blank against the walls of container it absorbs at least the half of working effort/force. If we press, for example, the dummy with a diameter in of half meter, then the required power of press will be 40 thousand tons. Such machines are unique, and their cost/value composes many millions of rubles.

High costs and low productivity interfere with the wide acceptance of pressure forging. Specialists consider this old technological process hopeless.



Rod they displace into helix.

Key: (1). Container. (2). Water.

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Second life of pressure forging beginning from Soviet engineer M. S. Kurnevich's invention. Engineer will propose to replace steel stamp with water. This is immediately removed both shortcomings pressure forgings. First, instead of the unique bulk of press now it will completely sufficiently be small high-pressure pump - compressor. Liquid presses in different directions evenly; therefore if we in the slender tube, which is connected with the enormous closed chamber, develop large pressure (for this will be necessary a comparatively small effort/force, indeed the cross-sectional area of tube is small), then the same pressure appears in the chamber. This is why small compressor is capable to replace colossal press.



The second. Pressure forging by water will sharply raise productivity. As soon as pressure is raised to the assigned/prescribed limit, is given out the knock, similar to shot, and from matrix/die as straightening spring, fast escapes ready article. No flaws and "rag bolt/brushes" its surface will be smooth, as if polished. Is explained this almost complete absence of the friction: dummy nowhere clear the walls of container, from all its sides encircles fluid. This fluid is leaked into matrix/die, forming on its surface finest film, the so-called hydrodynamic wedge, which wonderfully replaces lubrication. As concerns shot, is its reason in the compressibility of water. Although it is accepted to speak that the incompressible fluids, in actuality this not thus. It is more accurate to say that they are badly/poorly compressed. In any case pressurized water of 10 thousand atmospheres is compressed by 18 percent, stocking in itself in this case much energy. It is worth only to blank being touched from place as friction sharply it descends (friction of motion always less than static friction) and the energy, preserved in water, instantly is free/released, ejecting blank.

The method of pressure forging metals by water is studied at first scientists in the laboratory of high-pressure physics of the AS USSR under L. F. Vereshchagin's guidance, then it will be taken workers.

To engineers in general will like itself original technological process, if not its one essential shortcoming. As will show calculations, the pressed dummy compulsorily it had to be short and thick, otherwise to it threatens known by all, who study strength of materials, buckling. Similar to too long and fine/thin a column, it must be bent and be broken in container, so and not in passing by through matrix/die.

But thus once (inventions even in our time are frequently connected with chance) metal worker on carelessness will place into container instead of the ideally direct/straight rod bent, similar to boomerang. To engineers's surprise who after metal worker's report/communication repeatedly repeat experiment, the bend of blank it does not not at all prevent pressure forging. Careful testing will show the error in calculations. Calculations apply the formulas, which did not consider the lateral pressure of liquid on blank.

Engineers will immediately realize the importance of the unexpected discovery/opening. Once buckling is not terrible, which

means, that it is possible to press the rods of the unlimited size/dimension.

Theoretically task was solved, the last/latter constrained limitation of progressive method removed. But will virtually arise new problem. What is to be done with container, indeed it it is necessary to now make with length several hundreds of meters?

Inventors L. D. Gol'man, <sup>D.P.</sup> ~~A. R.~~ Prokhorov and A. I. Kagalovskiy from VNII metallurgical machine-building again will recall about bend. Indeed if it is possible to press the bent rod, then why it is not possible it to generally roll up into helix both the spring? They will try; it will be obtained.

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So is born the fangle (author's certificate 138208), making it possible molded parts by length although into whole kilometer. But this has grandiose practical value, for example, for the further electrification of our country.

In the course of completing the program of KPSS [ КПСС - CPSU ] us must construct millions of the kilometers of electric power lines. Where to take astronomical quantities of scarce copper from which are



made the wire/conductors? True, copper can be replaced with aluminum which in the earth's crust as much as desired, but electrical conductivity in it is less than in copper, and for togas in order not to increase energy loss, aluminum wire/conductors must be much thicker. one trouble will entail another. Times is thicker, and also, therefore, it is heavier. Moreover are raised loads due to wind, increases in winter the weight of freezing on wire/conductors ice. As a result sharply grow/rise breaking stress, forcing to make wire/conductors still thicker, the flight/spans among supports - are less, supports themselves - are stronger, more massive. All this raises in price building. Electricians prompt simple output/yield. They propose to use the bimetallic wire: steel core will bear load, and on aluminum shell flows current.

But that which is simple for electricians, is complicated for the metal-workers: how you will manufacture which wire/conductor? You will put on to steel rod aluminum tube and you will begin to draw? Nothing will be obtained. Soft aluminum tube is thickened, and rod will remain, which it was.

Pressure forging according to the method of Gol'man-Prokhorov-Kagalovskiy for the first time in world practice is allowed, after joining steel and aluminum, to obtain bimetallic wire. For this, into container is placed the convolute into helix aluminum

tube with steel core and is connected pump.

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Under effect of pressure and aluminum, and steel are pressed equally, forming simultaneously strong joint with each other. The most valuable, that thus it is possible to obtain the wire/conductors of the virtually unlimited length.

Inflating die/stamp.

Elastic instruments for pressure forging by the powder

Any five-year little-one according to his own experiment is solidly confident: sand "cakes" are obtained well only from those molds whose hole has larger diameter than base. Otherwise cake with whole not to take out. Since die forging is based on the same principles of shaping, as the children's play, the same laws affect and here. True, press men recently learned to manage without drafts and to stamp parts with transverse and cannelures and fin/edges, but this will entail the sharp complication of construction and the rise in price of die/stamps. Instead of two massive steel halves with the

milled out in them figure cavity, it is necessary to design intricate mechanisms with by the whimsical, accurately designed kinematics, with those built-in in them pneumo- and hydraulic cylinders, that consist of dozen levers, the wedges, the gears. And nevertheless of complete universalism is not possible to achieve: the parts, which yield to stamping,, until now, much less than those who are not yielding. Therefore after their stamping it is still necessary to mill, to turn or to shape.

Is especially unpleasant this in cases when parts press from powders. Indeed the basic raw material of powder metallurgy - carbides of titanium, tungsten, silicon, iron, that make it possible after sintering to obtain exclusively solid, heat-resistant stable to abrasion alloys of the type "will conquer".

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And here are these materials whose the basic advantage of consists of their persistent resistance to of every kind strains, it is necessary to work. Comes to nothing and another important advantage of powder metallurgy - its cost-effectiveness/efficiency. Instead of 1-5 percent the departure/withdrawals begin to compose 20-30, and that also 40 percent as usually.

In order to facilitate treatment, they attempt to enter thus: the stamped parts sinter not immediately. "semifinished products" they place them on machine tools and sinter completely only after finishing treatment. But nevertheless is obtained dearly and inconveniently. Necessary will be the method, which immediately makes it possible to obtain parts with minimum allowances. Not to try to make the melted or burned out die/stamp, like model during precision casting? Alas, this method clearly is not arranged. Unlike casting pattern, the die/stamp, designed to considerable working effort/force, must be durable, so that to make its each time does not anew have sense. Thus if it is possible without this strength to manage .... However, then will fall and the last/latter difficulty: from soft die/stamp it is possible to extract the part of any form. Is actual whether this? Perhaps it is possible by something soft to deform solid? True, to us is known sheet stamping by rubber punch/male die, but matrix/die-that nevertheless is made made of hardened steel. And all the same there is the method, which makes it possible to completely manufacture die/stamp from soft material. This hydrostatic pressure forging. For the first time it they proposed in 1924, and since then it will receive sufficiently wide acceptance. The powdered metal, filled into elastic plastic either rubber shell with the wall thickness of 0.1-0.15 millimeters, is dipped in water, glycerin or machine oil. Then with the aid of piston, shock waves or pump is created in liquid the high pressure, which reaches to one-two



thousand atmospheres.

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Pressure compresses powder and converts it into hard monolithic dummy. Soviet engineer B. A. Borok, is many occupied by the investigation of hydrostatic pressure forging, emphasizes its important advantages. Since pressure affects on powder from all sides evenly, the density of the obtained bar, its mechanical properties are constant over entire section/cut. Scarcely whether it is possible to overestimate the importance of this fact for the strength of future part. In a any other manner cannot be achieved such results. Since during hydrostatic pressure forging completely there is no friction between the part and a shell-die/stamp, required effort/force sharply is decreased, sometimes several times. Moreover and to create these effort/forces much more easily. Instead of the bulky thousand-ton press it suffices to have the small high-pressure small pump, moreover pressure from one pump can be brought to any number of simultaneously of active working chambers, and in each chamber it is possible to simultaneously press several parts.

A similar kind of settings up, designed in Central Scientific Research Institute of Ferrous Metallurgy press now 500-kilogram blocks, true, very simple forms - cylinders, cubes, polyhedrons. In

order to pass to pressure forging of the parts of arbitrary form, it remains to make the last/latter space: to replace elastic shell with the specially designed elastic die/stamp (English patent 781982, the patent of USA 2783504).

Its internal cavity must correspond precisely to the configuration of the pressed part, of course, taking into account the shrinkage of powder, which reaches sometimes fifty percent by volume.

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Wall thickness is selected with those by calculation so that the die impression would not be distorted with the filling of it with powder, but at the same time so that the pressure could without difficulty affect on part. Simpler anything it is possible to manufacture this die/stamp from liquid rubber, after applying it to wax mold. After congealing wax melts and instead of it form charges by powder. In order to avoid in the finished part of porosity, form they preliminarily evacuate, they evacuate from it air. Hydrostatic pressure forging in elastic die/stamps, as confirm inventors, makes it possible to obtain parts from molybdenum, tungsten, zirconium, titanium, vanadium, from carbides and their alloys with undercuts, with curvilinear internal cavities, recesses, for example twist drills and countersinks, bevel gears, worms, the housings of

reducers, carburetors, etc. The accuracy/precision of parts is the tenths of millimeter. Small grinding - and accuracy/precision reaches the hundredths of millimeter.

If the articles of powder metallurgy - wear-resistant nozzles for sand blastings, copper-graphite brushes of electric machines, piston rings, the sintered carbide tips of cutting tools, ferrite memory elements, the permanent magnets, the brake linings, diesel injectors, self-lubricating bearing, rod-retarders of atomic reactors - and now already became necessary for technology, then new highly productive, cheap, but main general-purpose method of stamping even more will expand the field of their application/use.

Tubes from powder.

Lengthened punch/male die. Sparks in polyethylene

The biographer Edison professor Lapirova-Skoblo in his book gives the characteristic case, which shows the riches of great inventor's creative imagination.

End section.

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"One of the engineers it will present to Edison three versions of the machine, intended for special work. Drawings will not satisfy Edison, and young engineer with regret noted that he does not know that to make it is further. Edison will ask: "you want to say that these drawings are the only possible solution to the assigned mission"? - "probably", will answer<sup>ed</sup> engineer. Edison nothing to it will say, but after two days, he will bring and it will place to this engineer on table forty eight of versions of the same machine, comprised by Edison himself"... It is instructive, not truth whether?

This it will be one of the methods by which Edison trains his colleagues. It is necessary to recognize that the method of fair, since most frequently for inventors is necessary to search for the new solutions when the most erudite specialists it seems that all the possible solutions are very long found. The success in this matter depends on the skill to roll up from the beaten roads, to select fundamentally new ways. And then assigned mission frequently it is possible to solve not by one, but by immediately several by methods. Specifically, so it will occur with the method of pressure forging



the parts of large length.

The parts, manufactured by the methods of powder metallurgy, conquer all the new fields of application. Tungsten filaments of electric lamps, the sintered carbide tips of cutters, wear-resistant sand-blowings nozzle, draw plate of wire drawing benches, the teeth of the boring bits, fuel equipment for diesels, turbine blades - all this is pressed from powder. Heat resistance, wear resistance, simplicity of technology, which makes it possible to immediately obtain the parts of the assigned/prescribed form, complete absence of departure/withdrawals finally convenience in the control of the porosity of articles - here are inestimable advantage of powder metallurgy.

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But at it the vulnerable place: we know how well to press the parts of simple form and small size/dimensions - gear, rings, bushings, but if part only more strongly is extended into length than it is placed, to manufacture it will be already impossibility. So, no one will be taken to press even simple cylinder or tube, if its length is greater than three times, exceeds diameter. And this is why. Imagine conduit/manifold by length in there are many kilometers, filled by liquid. With the aid of piston press on liquid. Pressure

immediately will be extended on entire conduit/manifold. In whatever place you connected to it manometer, everywhere it will show one and the same numeral. But if you replace are liquid by sand or any other powder-like material, then pressure wave will be propagated to very small distance. Further it will smother, it will absorb the friction of the particles of the powder between themselves and against the walls of tube. For this reason during stamping of parts from powder, the pressure actually affects only on the small section of the pressed article, which directly adjoins the punch/male die. Тfy-kA under such conditions to press the parts of the strongly elongated, extended form.

Moscow engineers Aleksandr Alexandrovich Mukaseyev, Pavel Fedorovich Balmer and Sergey Egorovich Salibekov will solve main task by amazingly simple, as would be expressed mathematicians, in a elegant manner (author's certificate 170266). They will leave the same press, the same punch/male die, the same mold. Is singular, that they will change, so this the order of heating.

... Into long cylindrical mold with shaped channel is inside filled blank - cermet powder.

On top in mold enters the punch/male die of press. Thus worker will press knob/button "launching/starting", and punch/male die with the force of many tons will compress powder. We already know that pressure act only on the adjacent to punch/male die zone. Well, and let. Automatically are included the electrical heating cell/elements, which warm precisely this part of the mold. The incandescent powder is sintered under the pressure of punch/male die, forming the solid top of part, while its remaining part remains almost cold. With light/lung click wear/operates the switch, and thus has already been heated the following section of mold. Since the coefficient of the thermal expansion of graphite mold is more than in the pressed material, during cooling between the solidified part of the part and the walls of form is formed small clearance. Force of friction of the top of part against the walls of die sharply falls, and the pressure of punch/male die without difficulty is spread further, pinching the following portion of powder. The solidified part of the part, thus, fulfills the function of the lengthened punch/male die. By the repeated displacement of hot zone it is possible to manufacture very long parts in which length at least twenty times exceeds diameter. If we utilize induction heating, process of sintering easy to automate, to make it continuous. It is necessary only circular inductor, which encompasses outside matrix/die, to force to move downward with the speed of sintering part. In order to double productivity, it is possible to press part by two punch/male dies immediately - upper and

lower. In this case, will operate two inductors, slowly moving to towards each other.

By the new method which the inventors will be call/named zone pressure forging, already will be possible to obtain pins from carbide of niobium and zirconium carbide with a diameter of five and by the length of one hundred millimeters.

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In 1774, almost two hundred years ago, the English scientist Neri cut thick copper wire on several pieces, he will connect them between themselves by slender thin wires and will dress up to the formed electrical circuit powerful battery of Leyden jars. By bright lightning simultaneously they will flare up, will explode in strong knock all thin wires and here they will burn out. ~~So~~<sup>So</sup> it will be possible for the first time to demonstrate experimentally that the currents in any section/cut of electrical circuit were equal to each other. Since then pass 100 years. No one is no longer interested in electrical detonated by wires. But thus will begin the era of photograph. Will be required the powerful light sources. On thin wires they will recall again. Similar to legendary Fenix, will revive they in glaring flash bulbs and again they will be loaded into lethe of oblivion. And only in recent years of physics they will interest



themselves in earnest in the detonated thin wires. Although, in order to open this phenomenon, in its time will be required only slender metallic filament yes the pair of Leyden jars, to explain its completely physicists will not know how, until now,. It is clear only, that thin wire, being heated because of Joule heat, it boils and with explosion it is converted in pairs. Investigations are impeded by the also fact that all this occurs in milliseconds.

But one way or another - thin wire the convenient source of superbright light, superhigh temperatures and powers. In the sea research laboratory of the USA, where the thin wires attempt to utilize for the initiation of thermonuclear fusions, metallic filament one microns in diameter, being detonated, it gives temperature in hundreds of million degrees it develops peak power into 100 million kilowatt, nearly equal to the overall power of all Soviet power stations.

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Detonating thin wires in the massive bomb, filled with powder-like graphite, it is possible to obtain diamonds. But from the viewpoint of the specialists in rocket engineering of thin wire is a tempting "fuel/propellant" for spacecraft. The velocity of the dispersion/divergence of generatrices after the explosion of the thin

wire of gases reaches 80 kilometers per second - 20 times, it is more than in the best chemical fuel/propellants. Since the thrust/rod of rocket, as is known, is proportional to the exhaust gas velocity, it is understandable, which prospects open/disclose the thin wires before the space with technician. The efficiency of this process reaching 80 percent. Yes even to store solid wire and to handle it are more convenient than with gas or liquid.

They have an application of a thin wire, also, in metal working. With their aid it is very convenient to weld metals with ceramics, with the semiconductors when common methods are inapplicable due to the undesirability of heating.

Ceramic bar tightly is pressed to iron core, after laying between them finest tantalum foil. During discharge the foil for the portions of millisecond is carried through liquid and vaporous phases and solidifies again, tightly welding metal and to ceramicist. Most interesting here from the viewpoint of engineer that that the strength of connection by entire section/cut is differing: indeed thin wire or foil are detonated immediately with identical intensity at any point.

This fact will use Minsk inventors L. Boginskiy, I. Kabel'skiy, P. Loginov, O. <sup>ROMAN</sup>~~ROSEL~~ Yu. Sharin and V. Korotkov from Belorussian

polytechnic institute and the energy institute the A.S. of the B.S.S.R (author's certificate 173105).

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After clashing with the need for pressing from powdered metal of tube, for example the guide bushings of automobile valves, they, logically, first of all they will recall about explosive stamping. But with usual explosion scarcely whether it is possible to ensure the uniform pressure field of large extent. But by the detonated thin wire it is possible: several microseconds, thus far occurs its evaporation, insufficient for developing any strains. Retaining the form of its axle/axis, thin wire melts, it boils up finally the bubbles of the incandescent metallic vapor are drawn off in solid column of intensely compressed gas, and follows explosion. The blast wave of ideally cylindrical form appears strictly simultaneously about entire length of conductor. It is logical to expect that the properties of the parts which it will press the so/such modern instrument, will prove to be very high.

Tests of the new method were conducted on the test bench of the energy institute the A.S. of the B.S.S.R. In cylindrical matrix/die - thick steel tube - they charge the iron-graphite powder, and along the axis of tube, they will insert plastic "candle" - cylindrical rod



with its penetrating metallic filament. To filament they will connect powerful generator of pulse currents. "Four, three, two, one, zero!" The cluster of energy into 8000 joules instantly will turn a thin wire-conductor in of pairs. Swelling, <sup>like</sup> both ~~both~~ boa constrictor, glaring gas so/such and will print the particles of powder to the wall of die. The obtained bushing (ratio of length to wall thickness is equal in it to thirty five) do not have porosities, after splitting off and cracks. Its density by entire volume will be constant. This it will be possible to achieve because of the radial direction of pressure forging and the insignificant displacements of the particles of the powder. Since to wire candle it is easy to give any form, new method offers the possibilities of pressure forging the good-quality parts of the most complex configurations from the tungsten, titanium, molybdenum, niobium and other low-plasticity powders which thus far as follows generally no one to press it knows how.

As concerns the material of "candle" and thin wire, then most adequate/approaching proved to be polyethylene and tungsten or Nichrome.



### Magnetic Explosion Breaks Technology

On academician P. L. Kapitsy's forecast. Sealed joints without welding. Assembly of insulators, aircraft thrust/rods, automobile hinge joints and steam boilers. Lines of force act on metal.

Almost four decades ago, in 1927, in the works of English royal scientific society was placed academician P. L. Kapitsy's article. In this article Peter Leonidovich for the first time in world literature imparts on the enormous mechanical forces, appearing under the effect of powerful magnetic fields on metal. Kapitsa himself in any way was interested in the appearance of these forces. On the contrary, they interfered with it to carry out fine/thin physical experiments on research on the action of strong magnetic field on elementary particles, to observe, does affect it the velocity of propagation of world/light.

For obtaining the magnetic fields of the high intensity/strength of Kapitsa, it short closes not solenoid coil powerful storage batteries, but the appearing effort/forces frequently it destroy. Thus these harmful from the viewpoint of the experimental physicist of force fruitfully utilize now engineers, specialists on magnetic stamping.

Thus, the basic physical principle, on which is based magnetic stamping, widely-known already forty years ago, but nevertheless it will not develop.

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Almost thirty five years is it in incipient state, and only into 1961-1962 in the USA appeared the first industrial settings up of "magneforms," the molded parts by the impact/shock of magnetic field. So long "incubation" period is explained not so much by engineers's conservatism, as by absence of the necessary equipment, namely powerful high-voltage capacitors with low inductance. To force electricians to develop/process these complex and expensive devices, without knowing still for sure, it will prove to be the new method of metal working sufficiently effective, it was matter risky and by virtually hopeless. Fortunately, here engineers will again aid the physicists: for the containment of high-temperature plasma in experiments in thermonuclear fusion, furthermore will be required superpower magnetic fields. Well, and for producing of these fields are necessary high-voltage capacitors. And they were created.

In Soviet Union above such condenser/capacitors by assignment of

the physicists, work the colleagues of the research laboratory of high-voltage engineering and converters of the current of the Kharkov polytechnic institute im. V. I. Lenin. Headed by laboratory head docent Saul Markovich Fertik they many years are occupied by high-voltage technology, develop/process the projects of the modern capacitive storage/accumulators and another equipment, necessary for control of thermonuclear fusions. The accumulated experience will allow laboratory to rapidly expand/scan works on the magnetic-pulse stamping. From the torque/moment of obtaining the assignment in 1963, pass not more than 6-7 months, as was already constructed the test bench, were developed the in general terms electrical and optical methods of study (but they are very complex), repeated all the technological operations, described in foreign literature.

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On this, is completed the first preparatory stage. Further stretches the field that which was not known, and in order into it to invade, one ought not to have gathered hearth by one banner with the electricians of the technologists, metallurgists, "pressure specialists," .....

As we already know that the operating principle of any magnetic-pulse setting up is based on what during capacitor discharge

through the coil around solenoid is formed the powerful pulse magnetic field, and in the placed hereabout blank appear the eddy currents, which interact with this field. As a result with sufficiently powerful capacitor blank press to matrix/die the enormous pulse mechanical pressures, measured by many thousands of kilograms to square centimeter. Such pressures make the material of blank plastic, it flows to easily are filled any forms. The duration of process does not exceed hundred-thousand fractions of a second. So that on velocity magnetic stamping - process, not having equal. The same it is possible to say, also, about its universality: magnetic stamping makes it possible to satisfy everything without exception/elimination the technological operations, available to any other forms of the pulse treatment: explosive, electrohydraulic, detonation so forth. But furthermore, it makes it possible to concentrate working effort/forces in any place of blank and makes it possible to combine effect of pressure from pulses, by heating. Actually, large eddy currents separate in blank much Joulian heat. Regulating the parameters of electrical discharge and the capacitance of capacitors, a quantity of this heat can be regulated over wide limits. The cosmic velocity of process in conjunction with powerful thermal shock converts the most brittle and most solid materials into soft and pliable as clay.



One Additional Essential advantage of stamping is high stability of technological process, the possibility of obtaining the absolutely identical parts. This is explained by the lightness/ease of precise batching of energy of impact/shock, which is completely determined by working tank and the number of condenser/capacitors of setting up.

The characteristic difficulty from which at the very beginning of their work they clashed Khar'kovian, is an extreme complexity of physics of the process of magnetic stamping, then that virtually it does not yield to calculation. Actually, according to the number of simultaneously participating here factors among which it is not possible to separate secondary in order them to disregard, it is unique. If common cold pressing is completely determined by mechanical properties and the strength of material, if explosive requires the additional account of the forces, then here still is added the calculation of pulse magnetic field in space and time, the task of calculation and propagations in the blank of Joulian heat, the effect of heat on compliance/pliability and the magnetic properties of metal, etc. As see, number mathematical, theoretical solution of problem almost is impossible. That means that it is necessary to experiment. But this not considerably more easily. In fact, where to take sensors, in order for thousandth and

hundred-thousand fractions of a second to measure the forces, the pressures, the velocities, the strains, the temperatures in the different parts of the blank and surrounding space? The common extensometers and the piezoelectric pickups, suitable for measurements during explosive and electrohydraulic stamping, cannot be utilized here: processes go many times faster, to the same interferes strong magnetic field. But without measurements it cannot be been dismantle/selected at the mechanism of process, it is not possible to consciously select technological mode/conditions, to mark the optimum form of curved pulse current, it is correct to design the worker of instrument.

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It was necessary to develop the unique metering equipment, suitable for measurements under such difficult conditions. In order to visually visualize the complexity of the problems, solved by researchers, consider into such numerals. The rate of the increase of the current, which reached in absolute value 165 thousands ampere, in one of the experiments composed 16 billion ampere per second, entire process of the deformation of tubular blank in other experiment it was continued only 70 milliseconds. Nevertheless engineers can demonstrate to you the oscillogram, which forever imprinted the rabid jumps of current, and photographic film on which it is distinctly evident, as changed the form of the tube through each 2-3 milliseconds. For this, was required virtuoso experimental techniques - the hypersonic movie cameras, making on 2.5 million photographs per second, the timing mechanisms of electrical discharges and photoflashes and much other. The significant part of the equipment it was necessary to develop/process by itself.

The conducted investigations made it possible to refine possibilities and advantages of magnetic stamping.

Because of the absence of the direct contact between the instrument and the blank and the accuracy/precisions of the batching of effort/forces in value and even in the rate of their growth/build-up, become possible the very fine/thin operations: the pressing of metallic parts to brittle articles made of porcelain and glasses (insulators), working parts in the sealed glass or plastic vessels, and also when it is not possible to concern them according to the conditions of sterility.

The combination of pulse heating by eddy currents with pulse loading makes it possible for one operation to stamp parts of the hard-to-deform alloys.

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With common methods for this, are required several operations with repeated intermediate heat treatments.

Instrument together with part it is easy to conclude into the soundproof shell, so that in shop are audible only weak clicks.

Is simplified the construction of die/stamps. Therefore becomes profitable stamping the low batches of parts.



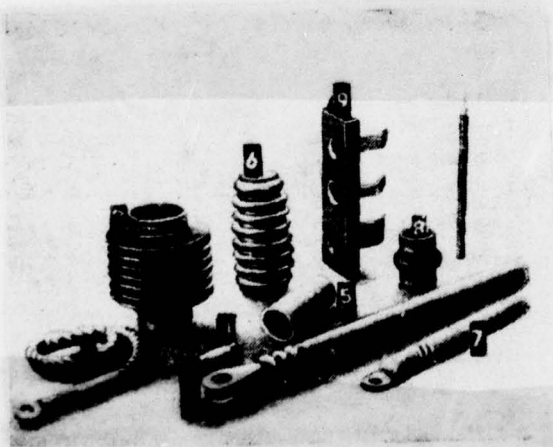
Is not required the highly skilled personnel. Everything which is required of operator, to insert blank, to press knob/button, to remove part. Therefore the setting up of magnetic stamping it is easy to build-in any transfer line. The productivity of setting up is 300-400 parts in hour and it is determined by operator's quickness. Since the necessary for stamping charge is accumulated for 2-3 seconds, during the automation of supply and the removal of its blanks be managed to build up, also, to 800-1000 parts in hour.

In Kharkov polytechnic institute is already developed the whole gamma of the magnetic-pulse installations (MIU), which are characterized by from each other in essence the maximum energy, stored by storage/accumulator. The master pattern MIU-20/1, which was being demonstrated into 1965 on VDNKh [ВДНХ - Exhibition of Achievements of the National Economy of the USSR], as can be seen from its name, it is designed to 20 kilojoules.

It consists of the charge step-up-rectifying device, fed from mains, capacitive high-voltage storage/accumulator - capacitor bank, instrument-inductor through which occur/flow/lasts discharge current, and the shaping matrix/dies. Furthermore, is slotted table "dovetail" for fastening of parts and instrument and communicator for the closing/shorting of the discharge circuit.

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Discharge occurs after to third auxiliary electrode they feed the igniting momentum/impulse/pulse, which helps spark to clear interval between two base electrodes. Costs of MIU-20/1 12-15 thousand rubles, while the American similar setting up "Magneform-12", designed on 12 kilojoules, bypasses into 25 thousand dollars. Quite expensive in of this type devices - high-voltage capacitors. At Khar'kovchan they are age/held approximately 20 thousand momentum/impulse/pulses of maximum power. In principle resource/lifetime can be brought also to one hundred of thousands, and to a million of momentum/impulse/pulses but such capacitors will manage more expensive.



Parts, stamped by magnetic field.

During the adjustment of new operation, the press man transfer/converts into manual control of storage/accumulator. Turning the knob/stick of regulating autotransformer, it selects optimum magnitude of the charge. Then is included electroautomatic, and all working operations are reduced to the setting up of part and the pressure of the starting button. It is obvious, to ensure complete automation and remote control will not present special difficulties.

As we already spoke, there are no such methods of working the metals by pressure, which it was not possible to perform by the means of magnetic stamping. However, not everywhere its application/use is economically justified. Kharkov scientists gave much attention and to this side of question they can give completely clear recommendations to technologists on this account.

So, one of the profitable operations render/showed the pressing of tips and the couplings on cables, wire/conductors, cables, cords, high-pressure hoses, aviation thrust/rods. Gain here not only technological, mainly it is expressed in an improvement in the quality and reliability of articles. So, the strength of the joint of the cable shoes to breakage increases on the average 2-3 times, and the transfer electrical resistance of contact is decreased double. That means that is decreased by half idle heating in this place. The reason for this effect it is easy to understand, if we cut cable together with tip. We will see, that all thin wires and tip were

converted into the one-piece/entire piece of metal. Apparently, the enormous, with lightning speed building up pressure is led to cold welding. The necessity for tinplating drops off. With testing of capron cords with the pressed by magnetic field tips the breakage always passes along cord.

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By magnetic squeezing without any welding it is possible to obtain pressure vessel, if we press shell to disk with the cut over its cylindrical surface ring groove. The metal of shell so will tightly fill groove, that the joint will become impenetrable. During of the leak of liquid or gas, it was not observed at a pressure of 150 atmospheres. Reducing tube from aluminum-magnesium alloy on steel bolt, on the internal surface of tube, it is possible to obtain good-quality thread. After rotary swaging easily is screwed from bolt. Thus it is possible to extrude thread, also, on the external surface of tubular part. Described method of obtaining the thread into hundreds (!) once exceeds on productivity all methods, which were being applied, until now,.

Reducing steel rods, it is very convenient to thin their ends. This operation frequently is required with the drawing when it is necessary to insert the tip of the rod into draw plate draw plate.



Usually workers preliminarily forge rods under press, holding them in hands, giving to them hexahedral form, and then already round faces. With such a technology the vibration is transferred to hands, are frequent the diseases by vibration illness/sickness/disease. Magnetic technology, successfully tested on Kuibyshevskiy metallurgical plant, completely frees workers from similar troubles.

Giving out tubes by magnetic field, boiler-makers are rapidly pressed them into tube disks, where the fitting holes do not need the precise perfecting: pressures are so/such great, that any inequalities are smoothed and metal flows in in all slots, making joint still stronger.

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Among other economically profitable operations it is possible to call/name the distribution of tubes to cone, union coupling between themselves without any welding and rations by means of pressing their for each other, straightening/trimming of plates magnetic hammers, bending and the pressing of parts with electrolytic platings (any instrument, rougher than magnetic field, it compulsorily injures the fine/thin tender film). Magnetic field ideally stamps on metallic plates all possible tables, figures, matrix/dies, etc. If we give the end of the tube, after giving to it spherical form, and to then

introduce there the end of the second tube and to give it from sphere somewhat smaller diameter, we we will obtain the so-called ball joint. The use of similar hinge joints, well-packed by grease, in automobiles makes it possible to lubricate suspension 50 times thinner: through each of 50-75 thousand kilometers of range/path.

The absence of adequate production experience (, until now, the series issue of units for magnetic stamping is not still fixed and all works were carried out on laboratory and experimental machines) does not make it possible to impart detailed technical and economic information. But even separate examples give a sufficient representation of the saving of process.

So, on one of the Kharkov plants it was necessary to stamp during day on 2000 bases of magnesium alloy with a diameter of 30 and with a thickness 1.2 millimeters. Each base for worker was necessary preliminarily to heat by acetylene torch directly in die/stamp to 300°C. During magnetic stamping the heating proved to be necessary. Individual production time was lowered from 10 to 1 minute, savings on each part was 25 kopecks, and the setting up, occupied only during this one operation, completely was paid after several days.

It is obvious, the more full to estimate the possibilities of magnetic stamping and to find for it the new fields of application will be able only workers themselves, the workers of the different branches of industry.

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